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THREE NEW SPECIES OF NORTH AMERICAN ORTHOPTERA

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University of Miami, Coral Gables, Florida

The specimens described below have come to me through the generosity of Dr. Joseph Knull of Ohio State University, District Inspector F. T. Scott of the California Department of Agriculture and Mr. Clyde Stroud of the University of Chicago. All the specimens are at present in the author's collection.

Family **Gryllacrididae**

Gammarotettix aesculus new species

Comparison of specimens of the present species with those of *genitalis* Caudell, *bilobatus* (Thomas) and *cyclocercus* Hebard shows closest relationship to be with the last although it also resembles *bovis* Rehn, as judged by Rehn's (1941) description and figures. The entire series of *aesculus* was collected by Inspector Scott.

Holotype.—Male, Ash Mt., Sequoia Natl. Park, May 5, 1949 (author's coll.).

The insect shows the usual characters of *Gammarotettix* Brunner; fastigium of vertex short and widely bifid, legs short, dors edges of hind tibiae without movable spurs and not serrulate b tween the spines, body short and obese. Since the general appearance of the species of the genus is so similar description will be directed to those structures of taxonomic worth.

Posterior edge of tenth abdominal tergite broadly and weakly, arcuately produced at middle, there deeply and linearly cleft, its lateral margins in profile straight. Cerci abruptly bent at mid-length, their apical portion directed slightly upward and aciculate. Suranale broadly oval in outline, its dorsal surface widely and shallowly excavated, its distal edge with a median arcuate excision, which is bounded by a fairly high ridge. Subgenital plate similar to that of *cyclocercus*. Length (straight line) 13 mm.

Allotype.—Female, data as for type.

Essentially identical to the holotype in structure excepting the abdominal terminalia. Ovipositor with four ventral teeth, of which the most basal is very small, and terminal hook, and four dorsal teeth, including the terminal uncus. Subgenital plate triangular, its sides feebly sinuous, its apex produced into a short, acute, upturned spine.

I have examined beside these two specimens twenty-nine males and fifteen females (all paratypes) and a series of nineteen immatures. Considerable variation in color is shown, especially by the immature specimens, some of which are strongly mottled with black and yellow-white. The holotype has a broad black band on each side which begins on the metanotum and is broadest on the third and fourth abdominal segments. None of the other adults shows this band except as a small triangular area on the metanotum.

Accompanying the specimens were notes that this *Gammarotettix* is "known locally as buckeye hoppers because they are frequently found on buckeye trees (*Aesculus californica*) in early spring. These crickets disappear as soon as the vegetation begins to dry up and, while they are probably still there and mature, they must become very secretive. They are plentiful and commonly used bait for trout fishermen in the early spring but seem to be unobtainable after the first of June."

Ceuthophilus cacogeus, new species

Holotype.—Male, Malpais near Carrizozo, New Mexico, July 27, 1947, Clyde Stroud (author's coll.).

Fastigium of vertex bluntly rounded, eyes small, interocular distance about twice the long diameter of eye. Front coxa with a small lateral tooth, middle coxa with lower angle not produced. Front femur with a large preapical spur on ventrocephalic carina, preceded by a smaller spur (this absent on opposite femur). Middle femur with a large genicular spur, both its lower carinae with small spines. Hind femur slender, both its ventral edges with minute, widely spaced denticles. Hind tibia with a single preapical ventral spur, its dorsocaudal calcar about two thirds as long as metatarsus, which is as long as the following three joints united. Spurs of dorsal edges pallid. Ninth abdominal tergite somewhat produced but not heavily sclerotized. Subgenital plate divided by a median fold, its apices broadly obtuse-angulate. Pseudosternite as figured, with well developed lateral auriculae, which are finely crenulate; ventral rami strongly sclerotized and extended dorsally to meet the auriculae. Cephalic lobe rather short, distally subtruncate with its margin entire. Length of pronotum 3.5 mm., of front femur 5.5 mm., of hind femur 10.7 mm.

Allotype.—Female, data as for type.

The description above is equally applicable to this specimen excepting the terminal structure of the abdomen. The ovipositor is slender, long, very similar to that of *C. pima* as illustrated by Hubbell (1936, pl. VIII, fig. 103). The apex of the dorsal valve is a little upturned and acuminate; the ventral valve has four short, sharp, widely spaced teeth and terminal hook. Length of pronotum 3.7 mm., of front femur 5.5 mm., of hind femur 11.2 mm., of ovipositor 10 mm., its inner valves one-sixth shorter.

In color the specimens are gray-brown, the head and femoral bases clay yellow, the hind femur with the usual pattern of light bars. The pronotum has a row of four pale spots behind the front margin, another row of eight spots before the hind margin and a large yellow area on each side. A very narrow, pale median line traverses the thoracic nota. The body is sparsely clothed with minute setae.

Mr. Stroud collected an additional six males and sixteen females and eleven immature specimens in molasses traps set near cinder cones. All the adults are designated paratypes. The outstanding variation

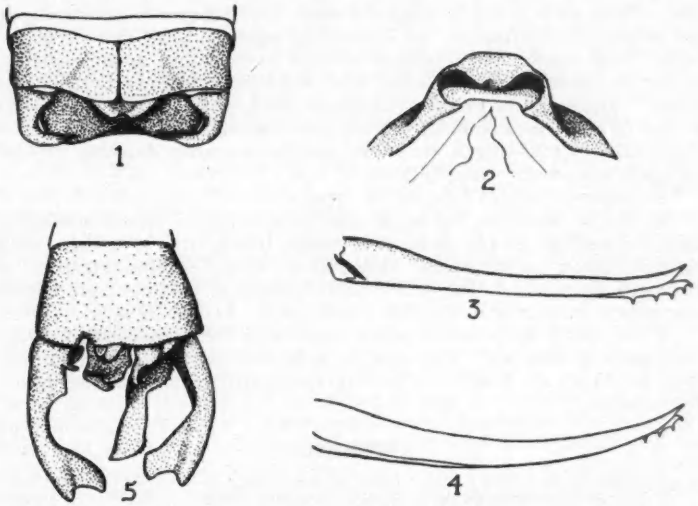

FIG. 1. *Gammarotettix aesculus* n. sp., apex of male abdomen, dorsal view. FIG. 2. *Ceuthophilus cacogeus* n. sp., pseudosternite of male, caudal view. FIG. 3. *Ceuthophilus cacogeus* n. sp., ovipositor of allotype. FIG. 4. *Ceuthophilus cacogeus* n. sp., ovipositor of paratype female. FIG. 5. *Timema knulli* n. sp., apex of male abdomen, dorsal view.

seen in the series is in the ovipositor. In length the extremes of this structure are 8 mm. (two specimens) and 10.7 mm. (one specimen). The longest ovipositor shows a decided curvature.

This species is of the *yavapai* group, its closest relationship probably being with *leptopus* Strohecker, from the Organ Mts. Mayr (1942, p. 141) has suggested that many of the presently accepted species of *Ceuthophilus* may be components of some thirty "biological species," and accumulation of sufficient material may well give substance to his conjectures. The form here discussed, however, would merit a name under any taxonomic system and, in the absence of other evidence, is announced as a species.

Family **Phasmidae** (s. l.)

Timema knulli new species

Holotype.—Male, Monterey Co., Cal., June 24, 1941, D. J. & J. N. Knull (author's coll.).

Larger than any yet described species, fairly robust. Head much as in other species but with postocular areas more swollen. Pronotum deeply excised on each side for reception of occipital swelling, its front angles decidedly acute. Body form as usual in the genus, tenth abdominal much broader than the several preceding, its distal margin deeply notched internal to base of left cercus. Left cercus broad at base, there with a fairly large internal tooth, beyond this abruptly and angulately narrowed but expanding again toward the asymmetrically bifid apex. Right cercus slender at base, its apex somewhat similar to that of left cercus but with the internal ramus broader and flatter. Intradextral process (Tinkham 1942, p. 73) similar in general to that of *californica* Scudder but narrower throughout and considerably constricted at mid-length, its lateral margin minutely dentate, its apex obliquely rounded. Length 20 mm.

Allotype.—Female, data as for type.

Similar to holotype but larger and more robust. Tenth abdominal tergite considerably produced over cercal bases, with a median longitudinal furrow in its apical half and its distal margin broadly but fairly deeply notched. Subgenital plate triangular, its sides continuously convergent from near base to the acute apex. Length 27 mm.

Three males and three females taken with the above specimens are designated paratypes. This species is nearest *californica* Scudder and may be shown eventually to be a large, strongly differentiated race of that species.

REFERENCES

1. **Caudell, A. N.** 1916. The Genera of the tettiginiid insects of the subfamily Rhaphidophorinae found in America north of Mexico. Proc. U. S. National Museum 49: 655–690.
2. **Hebard, Morgan.** 1916. A new species of the genus *Gammarotettix* from California. Ent. News 27: 65–66.
3. **Hubbell, T. H.** 1936. Monographic revision of genus *Ceuthophilus*. Univ. Florida Biol.Sci. Series 2(1): 1–551.
4. **Mayr, Ernst.** 1942. Systematics and the origin of species. Columbia Univ. Press, 334 pp.
5. **Rehn, J. A. G.** 1940. A new *Gammarotettix* from Arizona. Notulae Naturae, No. 61.
6. 1941. A new Californian species of *Gammarotettix*. Notulae Naturae, No. 85.
7. **Strohecker, H. F.** 1947. Some southwestern Gryllacrididae. Ann. Ent. Soc. America 40: 241–246.
8. **Tinkham, E. R.** 1942. A new Californian species of *Timema* with zoogeographical notes. Bull. So. California Acad. Sciences 41: 72–80.

OBSERVATIONS ON THE BIONOMICS OF CULICOIDES TRISTRIATULUS HOFFMAN WITH NOTES ON C. ALASKENSIS WIRTH AND OTHER SPECIES AT VALDEZ, ALASKA, SUMMER 1949

(Diptera, Heleidae)

ROGER W. WILLIAMS[1] [2]

To the genus *Culicoides* (Diptera, Heleidae) belong those small haematophagous gnats which are commonly referred to as "punkies," "no-see-ums," "sand-flies," and in some areas of the Arctic "mooseflies." Hill (1947) discusses the existing knowledge concerning the bionomics of this genus, the paucity of which is in marked contrast to the vast amount of accumulated information pertaining to other blood-sucking pests.

The biology, taxonomy, distribution and habits of "no-see-ums" in the Arctic areas have not been studied in detail. Jenkins (1948) presents some general information on eight Alaskan species (now reported to be six—Wirth (1951)). Sailer *et al* (1949) and Pratt *et al* (1949) report further information (not available at the time of this study). The immature stages have been described for only one species found in this territory, *C. obsoletus* Meigen (Hill, 1947).

Throughout the summer months the citizens of some of the coastal towns of Alaska are plagued by a "giant" species having a wing spread of about 5 mm., *C. tristriatulus* Hoffman, which at times becomes so numerous as to prohibit the unloading of ships and which is said to be little affected by known insect repellents. A species which is very similar in appearance (and often confused with *C. tristriatulus*) but occurs inland and has not been reported from the coast is *C. cockerellii* (Coq.). During the months of June, July, and August, 1949 a bionomic study was made of *C. tristriatulus* at Valdez, Alaska, in order to facilitate the development of a control program directed toward the destruction of this fly in its immature stages. While this investigation was under way, a new species, *Culicoides alaskensis* Wirth, was recovered and a few observations pertaining to its bionomics were recorded.

Valdez, one of the two seaports on the southern coast of Alaska from which materials are shipped into the interior, has a summer population of about 500 residents. It is situated in an arm of Prince William Sound at 61° N. latitude and is completely surrounded by

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[2]With the technical assistance of Marjorie M. Williams.

Sincere appreciation and thanks are due to the School Board of Valdez, Alaska, for their permission to use a laboratory in the schoolhouse; to Mrs. Katharyn A. Fawcett, weather observer of Valdez, for climatic data; to Dr. G. N. Jones, Associate Professor of Botany and Curator of the herbarium, University of Illinois, for the floral identifications; and to Mr. Willis Wirth, Division of Insect Identification, National Museum, Washington, D. C., for verification and identification of *Culicoides* spp.

mountains. The normal average daytime temperature for this community is 35.8° F., that of the warmest month, July, 53.2° F. and of the coldest, January, 19.2° F. The normal total precipitation is about 60.5 inches. The prevailing wind during the summer is W.S.W. blowing at an angle across the fiord. For the 12 months, July 1948 through June 1949, the average temperature was 31.1° F. while the precipitation was 74.8 inches. This year, therefore, was not a year of normal weather conditions and "natural" development was considerably retarded, gardens as much as 4 to 5 weeks.

METHODS

In searching for the breeding places of *Culicoides* spp. two techniques were employed: (1) recovering immature stages from muck samples as described by Dove, Hall and Hull (1932) and (2) collecting the pupae in the water of their natural habitat by dipping with 10″ white enamel pans. The technique of Dove *et al.* consists of placing a crystallization dish containing a soil sample (from 200 to 250 c.c.) into a larger dish and adding tap water until the sample and smaller dish are completely submerged. The larvae migrate to the edge of the larger dish and are trapped in the moat of water from which they can be picked up with a pipette. The dishes were inspected for larvae twice daily for three days after which the sample was discarded. This technique, the best for the time available, was not altogether satisfactory for it was found that it was possible to recover larvae from samples which had been standing six days when none had been recovered during inspections on previous days and that the small larvae of the second generation rarely made their appearance before the third day but would frequently appear on subsequent days. Lack of space and equipment did not permit observation of most samples for more than three days; therefore, a negative sample did not indicate that it or the area from which the sample came was not a *Culicoides* habitat but a positive sample indicated a breeding area. As samples were taken in the field and numbered, stakes with corresponding numbers were driven into the ground at the spot of collection. When larvae were recovered, some were placed in individual glass vials (14 x 45 mm.) containing ¼ inch of soil from the samples from which they were recovered plus tap water while others were placed in petri dishes with water enough to cover the bottom and a little soil. These larvae were kept at a temperature of 13° to 19° C. and permitted to develop further.

Culicoides larvae can be easily recognized by their characteristic motion which centers about points between the third thoracic and first abdominal segments and between the sixth and seventh abdominal segments. As the head and thoracic segments and last three abdominal segments move in one direction, the first six abdominal segments move in the opposite direction, then the motion of all segments suddenly reverses. At times this motion may be so rapid that a larva will appear only as a blur.

The hydrogen-ion concentration of samples was determined with a Hellige A-N-A Testkit, short range model No. 682 (pH range 4–8). The salinity of soil samples was tested by means of a titration technique modified from that used by Kaye and Castillo (1944).

Adult flies caught in nature with an aspirator from hats, jackets, white or red cloth, were placed in groups of 30 in glass lamp chimneys the bases of which had been inserted through the lids of circular pint cardboard containers and fastened to them with scotch tape. The bottoms of the containers were lined with filter paper. The top of each chimney was covered by a double layer of rubber dental dam. Each layer had a ½ inch slit cut into it and these were placed at right angles to each other. The flies were introduced into a chimney by inserting the collecting aspirator through the slits. Likewise, the adult females were fed by inserting a finger and/or water soaked raisins on strings through these openings. It was not necessary to add any more moisture to these chambers. Some adults were kept alive for more than three weeks. Eggs, when deposited, were found on the filter paper where it was moist from contact with the wet raisins. This method of keeping the adults was rather unsatisfactory since heat from an inserted finger would cause moisture to form on the inside of the chimney to which the flies would adhere. Once they became attached to the glass they would remain there and die. Under these conditions the remaining adults displayed a marked reluctance to deposit eggs and the majority would die without ovipositing a week or more after the normal time for egg development. This was true even when small containers of water were placed in the chimneys for egg deposition. A large cage with a removable glass top, fine wire mesh sides, and a sleeve would probably be more satisfactory for keeping adults.

The eggs were collected and covered with water in a petri dish. After hatching, the young larvae were placed in vials containing soil from positive areas. None of the larvae handled in this manner could be recovered a week later. Perhaps, being confined to such a limited space, they were destroyed by other micro-life in the soil of which there was a great abundance.

Recovery cages described by Dove *et al.* (1932) were constructed for use as an aid in studying populations within restricted areas, however, their use proved to be impractical as will be mentioned later.

CULICOIDES TRISTRIATULUS

Random sampling for immature stages

Five-hundred soil samples were taken from the tide flats, banks of streams, marshy areas adjacent to Robe Lake (about 4 miles from town), "peaty" woodland regions etc., representing some 247 areas differing from each other either in location, type of soil, type of vegetation, water content, hydrogen-ion concentration or combinations of these differences. Larvae were recovered from only one type of habitat and the other 253 samples were taken from positive areas in this region.

Twenty-three larvae was the greatest number recovered from any one sample (after standing for only three days) and 30 (68%) of 44 samples taken from one area of about 300 square feet were positive for larvae. The concentrations of larvae in this area varied from 23 in the sample of less than ¼ square foot to 1 in an area of 1 square foot. What were considered and later proved to be last stage larvae of *C. tristriatulus* were found, by the muck sampling technique described, between June 4 and July 17. Pupae were

recovered in soil samples from June 16 until July 9, with the greatest concentration occurring between June 28 and July 9. Second generation larvae were found on August 9 and subsequent days.

From 50 to 159 samples taken from positive areas a total of 140 first generation larvae and 33 pupae were recovered (Table I). Larvae of the next generation were recovered from 8 of 34 samples taken from 6 to 15 areas which had been positive for first generation larvae. Since it was nearly impossible to see freshly emerged larvae in clear water with the naked eye, it is quite probable that many may have gone unobserved in the somewhat muddy water of the isolation units.

Habitat of the immature stages

To the south-east of Valdez for a distance of two miles the many streams entering the bay are for the most part of a glacial nature and carry and deposit large amounts of gray silt and stone, which with the

TABLE I

RESULT OF SOIL SAMPLING FOR IMMATURE FORMS OF C. TRISTRIATULUS AT VALDEZ, ALASKA, SUMMER 1949

	No. of Soil Samples Taken	No. of Different Areas Sampled	No. of positive (+) Areas	No. of Samples Taken in positive Areas	No. of positive Samples	No. Found	
						Larvae	Pupae
First Generation Immature Forms	406	247	15	159	50	140	33
Second Generation Immature Forms	94	15 (Areas positive for) First Generation Forms)	6	34	8	16	0

aid of the tides, form a beach of hard, compact, rocky, gray, clay in which little animal and vegetable life exists. No larvae or pupae were recovered from this area. In marked contrast to this beach, that on the north-west (windward) side of town is characterized by many streams fed by melting snow in which there is no silt and little rock. Vegetation grows here in abundance approximately 800 to 1,000 feet inland from the low tide level and generations of decaying plants have made certain areas quite fertile. It was only within a limited zone in the vegetation on this tide flat, between 0.8 of a mile and 2 miles from town, that *C. tristriatulus* was found in the immature stages.

Daily high tides of from 7.4 feet to 15.6 feet flow on these tide flats. The two daily tides are of unequal height so there is a zone in the vegetation which is for the most part covered by both high tides and another zone inland covered by only one high tide. All of the positive areas found to date occurred in one of two types of situations where the proper vegetation was to be found: (1) in a zone on the flats covered by

82 to 90 percent of all high tides or, (2) along the banks of the snow water streams which are covered by overflow water produced by each tide. The depth of the tide water over breeding areas varies during the course of a year from a few inches to nearly 7 feet. The average depth is estimated roughly at 18 to 20 inches which would mean that the breeding areas would be under water an average of approximately 6 or more hours each day.

A number of species of plants were to be found in the breeding areas, the most common one was a species of sedge, *Carex*, which was always present. In addition to the *Carex* the following plants were taken from one of the heaviest positive areas: ***Plantago maritima***, ***Glaux maritima***, ***Triglochin maritima***, ***Achillea millefolium***, ***Scirpus*** sp., ***Chrysanthemum arcticum***, and two forms of marine algae, one of which was probably ***Fucus*** sp. Many species of free-living nematodes,

TABLE II

TEMPERATURE AT WHICH DEVELOPMENT OF C. TRISTRIATULUS OCCURS AT VALDEZ, ALASKA

	Air Temperature	Soil Temperature	Water Temperature
No. of Readings	43	30	12
High	68° F. (20° C.)	60.8° F. (16° C.)	68° F. (20° C.)
Low	47.3° F. (8.5° C.)	47.8° F. (8.8° C.)	47.3° F. (8.5° C.)
Average	52.2° F. (11.2° C.)	54.3° F. (12.4° C.)	55.2° F. (12.9° C.)

which appeared to be associated with the algae, were frequently common in samples from positive areas as well as ostracods, copepods, cyclops, and other plankton organisms.

All soil samples from positive areas were acid in reaction, ranging in pH from 6.2 to 6.6 with an equal number of samples having a pH of 6.3, 6.4, and 6.6. Many samples had a strong hydrogen sulfide odor although this was not characteristic of all breeding areas.

C. tristriatulus cannot be considered a true salt water breeder at Valdez during the summer months. So many fresh water streams enter the bay that the surface or tide water when titrated showed less than 4,500 p.p.m. of chlorides. Water from soil samples in positive areas contained from 1,350 p.p.m. to 5,100 p.p.m. as compared to normal sea water of 35,000 p.p.m. The average of 25 samples was approximately 3,000 p.p.m. However, during the winter it would appear that when the sources of all the fresh water entering the bay are frozen, the chloride content of the tide water would increase considerably.

The average day-time air, tide water (at ground level), and soil (1″ below the surface) temperatures at one breeding area are given in Table II. The average temperature at which the early and later phases of immature development take place is approximately 13° C. (55° F.).

The temperature of the tide water plays an extremely important part in the development of *C. tristriatulus* at Valdez as evidenced by the fact that the adults appeared nearly on schedule following a year of low average air temperature while the emergence of other insects and plants were retarded. This tide water temperature may vary considerably in short periods of time and frequently is much warmer than the air temperature (Table III; the dates used are taken from the period when the pupae were most numerous).

Because the breeding areas were under tide water which was deep enough to cover adult recovery cages and drown and wash out flies from the recovery jars, only one was used and three adults were recovered before it was removed by parties unknown.

TABLE III

VARIATION BETWEEN TIDE WATER AND AIR TEMPERATURES AT VALDEZ, ALASKA

Date	Water Temperature	Air Temperature
6/26/49	49.1° F. (9.5° C.)	48.2° F. (9° C.)
6/29/49	59.9° F. (15.5° C.)	50° F. (10° C.)
6/30/49	68° F. (20° C.)	59° F. (15° C.)
7/1/49	47.3° F. (8.5° C.)	55.4° F. (13° C.)
7/6/49	59.9° F. (15.5° C.)	55° F. (12.8° C.)
7/7/49	66.2° F. (19° C.)	56.3° F. (13.5° C.)
7/8/49	56.3° F. (13.5° C.)	59.9° F. (15.5° C.)
Average	61° F. (14.5° C.)	55° F. (12.7° C.)

Life Cycle

The first adults of *C. tristriatulus* of the 1949 season to be observed were seen at 7:30 p.m. on June 9. It is not unlikely that some were present a few days before this. One week later, June 16, they were first noted on the docks in town, the prevailing wind blowing from their breeding grounds in the general direction of town. The highest level of adult population in town occurred between July 4 and August 7 after which a gradual decrease was noted. They were still abundant on the evening of August 27, the last day of observation, which was 38 days after the last pupa was found. A conservative estimate of the normal length of life of a female would therefore appear to be about 45 days. In the laboratory, females, when permitted to feed on blood until replete, fed but once although given at least one opportunity a day. Some of these flies would remain alive for 3 weeks or more when given water-soaked raisins. When permitted to feed only on the raisins, they lived a maximum of 14 days and no eggs developed. Those which received no blood or raisins died within 3 or 4 days. In nature, after feeding on blood the females apparently dissociated themselves from

the unfed swarms, for of 1,444 adult females captured and dissected in the laboratory none had fed, as indicated by the presence of only undeveloped eggs and absence of blood in the gut. Whether they lay more than one batch of eggs is not known. Those adults which do not obtain blood for several days or weeks in nature no doubt feed on plant juices.

Eggs numbering from 42 to 81 developed within 15 days at a temperature of 16 to 23° C (60.8° F. to 73.4° F), the estimated average being 18.5° C. (65.3° F.), which is considerably above the natural temperatures at which egg development occurs. Therefore possibly a greater length of time is normally required in nature. Ten days after a blood meal the egg size was 410 μ x 81 μ, at twelve days 432 μ x 71 μ and when deposited 464 μ x 71 μ. The gravid females appeared to fall into two distinct groups according to the number of eggs developing, those which had from 69 to 81 eggs, averaging 77, and those which had from 41 to 46 developing eggs, averaging 44. When covered with tap water, eggs from the same batch would hatch in from 10 hours to 3 days at 18° C. (64.4° F.), which is in marked contrast to some other species which require from 1 to 3 weeks (Hill, 1947). The newly emerged larvae varied in size from 669 μ x 75.6 μ, with a head capsule measurement of 75.6 μ x 64.8 μ, to 842 μ x 86.4 μ, having a head capsule measuring 108 μ x 75.6 μ, within 24 hours of hatching. Whether an individual variation of this magnitude exists or whether there is a moult within a few hours of hatching is not known. In nature, the eggs are presumably deposited on the soil in the proper areas and hatch when covered by tide water. The young larvae then migrate into the soil to a depth of about an inch or less. The newly hatched larvae are barely visible. The second generation larvae recovered by the soil sampling technique measured 2.5 mm. or more in length. The winter is passed in the larval stage in the soil. It may be possible that some larvae reach the last instar before winter. By June 1 or before the first pupae appear and in this year, 1949, they were found floating in the tide water among the vegetation of the breeding areas until July 20 when one-man hour of dipping with a 10 inch white enamel pan in one of the most favorable breeding areas disclosed cast pelts but no living pupae. At 16 to 18° C. (60.8° to 64.4° F.) the pupal stage has a duration of from 7.5 to 9.5 days. Pupae apparently migrate to the surface of the soil early for some of those collected in the field required six or more days development in the laboratory before the adults emerged. In nature, therefore, these pupae are probably exposed to 16 or more high tides. Some pupae are carried away from areas of vegetation as the tide advances and therefore are not caught by the vegetation as the tide recedes and are carried out into the bay. It may be possible that such pupae are picked up by currents and at subsequent high tides deposited on the beach nearer town. Pupae carried out into the bay on windy days probably are destroyed by wave action.

Adult flies emerge from the pupal skins very rapidly usually within 20 to 45 seconds. They are light tan in color at this time. Within an hour to an hour and a half they become hardened and change to a dull black color and are then ready for flight.

The results of soil sampling indicated that mature larvae are not

carried through the summer into the next season so there is, therefore, one complete generation a year.

Adult Activity

Females of *C. tristriatulus* were found at Robe Lake on July 4th, a distance of 4½ to 5 miles from the known breeding areas. Since no similar breeding areas were found between the lake and the original sites, and since investigation showed that they were not breeding in the vicinity of Robe Lake itself, it would appear that the flight range of *C. tristriatulus* may be at least five miles or that pupal distribution by water currents in the bay may be extensive.

The peak of adult population occurred at about the same time as the salmon began to run in the snow water streams. Large populations of gulls and terms concentrated in the breeding areas of *C. tristriatulus* at this time and geese and ducks were also common on the tide flats after the middle of August. It would appear quite possible that the adult female flies fed upon these birds and perhaps upon some of the others such as the magpies, ravens, robins, chickadees, hummingbirds, sand-hill cranes, etc., as well as small mammals that live in and near the alder, birch and willow thickets near by.

The activity of the adult females is greatly influenced by light intensity, temperature, and wind velocity. On rare occasions a few bit ferociously in bright sunlight, but as a rule they preferred to attack in a more subdued light, although they were never observed in dwellings, even those without screens. Pratt *et al* (1949) found that they would be active in bright sunlight when the wind velocity was less than 3 miles per hour and that wind accompanying sunlight was primarily responsible for reduced activity. At a light intensity of 60 foot candles or less (meter directed straight up), such as occurred on most cloudy days, many adults would usually be active. At higher meter readings they were usually not active. Adults were not numerous at light intensities between 0 and 2 foot candles, while at 3 foot candles the populations were frequently very high (meter set for indoor lighting). Air temperatures recorded on evenings of adult activity studies varied from 46° F. (8° C.) to 57° F. (14° C.) with an average temperature of 50° F. (10° C.). Biting activity dropped at the lower temperatures although great numbers would be flying. On evenings when the wind velocity was somewhat above normal, no adults could be noted on the tide flats near the breeding areas (See Pratt *et al* (1949)) for correlation of activity with wind velocity and temperature). A normal rate of rainfall did not appear to interfere with adult activity.

The adults swarmed around the heads and shoulders of individuals, following them as they walked, and were dispersed in this manner as well as by the wind. They did not appear to be attracted to black as had been reported for some other species (Hill, 1947), but rather to white and red cloth, jackets, gloves or hats. Whether this was an actual color preference or whether they were attracted by the odor of the dyes or other odors is not known.

On several occasions the vegetation of breeding areas was swept with insect nets during sunny days in an effort to recover resting adults. None were found.

An attempt was made to determine the index of adult population throughout the season by determining landing rates per unit area per unit of time, several nights each week. It was found that this method was impractical for adult activity was influenced to such a great extent by light intensity that observations had to be made on this basis rather than at a given time each day. Changes in wind velocity from day to day and from minute to minute was also a critical factor. On evenings of low temperature, although there were great numbers of females flying about, few would land while at other times the observation locality might be directly in the path of a swarm which would stay with the observer as long as he was available. Attempts to ascertain the population density by pupal counts per unit area dipped, utilizing the same dipping area each time, were unsuccessful. It was found that the population of pupae varied so tremendously within a relatively small area and, further, that since pupae are carried about by the tide for several days, one could never be certain how many had floated in from another area on any given day.

CULICOIDES ALASKENSIS AND OTHER SPECIES OF HELEIDS

C. alaskensis

This species, according to Willis W. Wirth, is a member of the *crepuscularis* group and therefore related to *C. canithorax* of the southeastern United States and to *C. circumscriptus* and *C. salinarius* of Europe. It was occasionally found in the breeding areas of *C. tristriatulus*. However, in one particular area on the tidal flats about 1.5 miles north-west of Valdez only the pupae of this species were found floating in the tide water between July 12 and July 18. They were no doubt present a considerable time before the 12th, but a study of this area was not made until that date. Larvae were never recovered and it is a matter of speculation as to whether they were breeding in this area or had floated into it by tidal action.

The vegetation of the region where these pupae were found consisted of a species of *Carex*, *Triglochin*, and a plant which was unidentifiable upon inspection some months later. All vegetation was much shorter and more sparse than that of the breeding areas of *C. tristriatulus*. The soil was slightly more acid, having a pH of 6.1, and the chlorides in the soil titrated at 3,000 p.p.m.

Several attempts were made to collect adults of this species in the vicinity where pupae were abundant. Only one male was ever recovered and this was from the surface of the water where it had recently emerged; no other adults were ever seen in nature. Although allied species may be serious pests in other parts of the world, this species does not appear to be so at this time in Valdez.

Other Species of Heleidae at Valdez

The following species of heleids were also collected at Valdez during the summer of 1949; *Culicoides obsoletus* (Mg.), *C. yukonensis* (Coq.), *C. unicolor* (Coq.), *Dasyhelea* 3 spp., *Forcipomyia* 2 spp., and *Bezzia* sp. Only one of the now recognized six species of *Culicoides* from Alaska was not reported, this being *C. cockerellii* (Coq.), the species that is so similar in appearance to *C. tristriatulus* but inhabits inland areas.

The adults of all *Culicoides* species other than *tristriatulus* and *alaskensis* were collected during the day from 10 a.m. to 4 p.m. between July 28 and August 4 in wooded areas and were not noticed particularly in town or on the tidal flats.

DISCUSSION

Control of *Culicoides* spp., as the successful control of all injurious insects, must be predicated on knowledge of the species, their distribution and their complete life histories. This investigation has disclosed, among other bionomic details, where *C. tristriatulus* is breeding near Valdez and at what period of the year the various life stages may be found. With this information it is now possible to experiment with various control procedures directed at the immature forms (use of insecticides, removal of top soil, etc.) to ascertain which is most effective and best suited for the existing conditions. It is probable that control measures which prove successful at Valdez might also be applied at other coastal areas where this species is abundant and where similar breeding situations exist.

SUMMARY

The life history of *Culicoides tristriatulus* Hoffman, was investigated at the seaport community of Valdez, Alaska, where it is a serious economic pest, in an effort to facilitate the development of a control program aimed at the destruction of the immature stages. The following facts were noted:

1. *C. tristriatulus* was found breeding only in a single region on the tide flats 0.8 to 2 miles N.W. of the town and within this region only in restricted areas where the proper vegetation was covered by 82 to 90 percent of all high tides or by the overflow of snow water streams produced by each high tide. The tide water would at times stand seven feet deep over some of the breeding areas.
2. Larval concentrations were found to be as high as 23 or more in a soil sample of 200–250 c.c. (about ¼ sq. ft. 1″ deep).
3. The pH of the soil of the breeding areas ranged from 6.2 to 6.6 and the chloride content of the soil from 1,350 p.p.m. to 5,100 p.p.m. averaging 3,000 p.p.m.
4. Adults were noted on June 9 near their breeding habitat and on June 16 in the town, the prevailing winds blowing towards the village from the breeding grounds. Highest populations in town occurred from July 4 to August 7. Adults were still abundant on August 27. Females probably live for at least 45 days.
5. One blood meal was necessary for egg development, others were refused. Eggs numbering from 42 to 81 developed in 15 days at an estimated average temperature of 18.5° C. (65.3° F.).
6. Eggs from the same batch hatched in from 10 hours to 3 days at 18° C. (64.4° F.), when covered by tap water.
7. Second generation larvae were found in the field on August 9 and subsequent days. They measured 2.5 mm. indicating that they had been developing for some time.
8. The winter is passed in the larval stage in the soil.

9. The first pupae appeared about June 1 and were found floating at high tides among the vegetation of the breeding areas until July 20.

10. The pupal stage has a duration of 7.5 to 9.5 days at 16 to 18° C. (60.8° to 64.4° F.).

11. Pupae are subjected to at least 16 high tides and some are carried from the breeding areas by receding tides and may be distributed further by currents in the bay.

12. The temperature of the tide water, which can change considerably from day to day and is frequently much warmer than the air temperature, plays an extremely important role in larval and pupal development. The average temperature at which the immature development takes place in nature is about 13° C. (55° F.).

13. Adults emerge from the pupal skin in 20 to 45 seconds and require from 1 to 1½ hours to harden before they are ready for flight.

14. There is one complete generation a year.

15. The flight range of *C. tristriatulus*, with the aid of the wind, may be at least 5 miles or more or else water currents play an important role in the distribution of pupae.

16. Adults which deposit eggs in the proper breeding areas probably feed on the birds which are attracted to these areas when the salmon are spawning.

17. The activity of adult females is greatly influenced by light intensity, wind velocity and temperature. They appear to be attracted more to red and white cloth than to black.

18. The pupae of a new species, *C. alaskensis* Wirth were found in one area, where it alone occurred, until July 18. The soil of this area had a pH of 6.1 and the chlorides in it titrated at 3,000 p.p.m. The vegetation was shorter and more scattered than that of the typical *tristriatulus* breeding areas.

19. Nine other species of Heleidae were found, none of which is of any great importance at Valdez.

LITERATURE CITED

Dove, W. E., Hall, D. G., and **Hull, J. B.** 1932. The salt marsh sand fly problem. Ann. Ent. Soc. Amer. 25(3): 505–522.

Hill, Marjorie A. 1947. The life-cycle and habits of *Culicoides impunctatus* Geotghebuer, *C. obsoletus* Meigen, together with some observations on the life-cycle of *C. odibilis* Austen, *C. pallidicornis* Kieffer, *C. cubitalis* Edwards and *C. chiopterus* Meigen. Ann. Trop. Med. & Parasit. 41(1): 55–115.

Jenkins, D. W. 1948. Ecological observations on the blackflies and punkies of central Alaska. Mosquito News 8 (4): 148–154.

Kay, S., and **Castillo, J. C.** 1944. A simple field test for chlorides in water. The Military Surgeon 94: 302–303.

Pratt, R. L., Morris, B. L., and **Daley, G. J.** 1949. Climatic studies: effect of meteorological factors in *Culicoides* activity. Interim Report No. O-137. Progress Report of the Alaska Insect Project for 1948. (Cooperating Agencies: Office of the Surgeon General; Bureau of Medicine and Surgery: Alaska Command; Office of the Quartermaster General; Engineer Corps; Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture), 68–70.

Sailer, R. I., Marks, E. P., Gregson, J. D., and **Morris, B. L.** 1949. Biology and identification of the bloodsucking Diptera: punkies (Heleidae) Ibid., 27–30.

Wirth, W. W. 1951. The genus *Culicoides* in Alaska (Diptera, Heleidae). Ann. Ent. Soc. Amer. 44(1): 75–86.

PROTEIN REQUIREMENTS OF THE COCKROACH BLATELLA GERMANICA (L.)[1]

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Early experiments by Zabinsky (1928a,b, 1929) indicated that the German cockroach could be grown to maturity on artificial diets in which the sole source of "protein" was glycine or gelatin. These early observations, based upon the use of relatively impure dietary ingredients and a very slow growth rate nevertheless indicated that the cockroach must differ in protein requirements from higher animals. Later studies by McCay (1938) who used more highly purified diets, indicated that "complete" proteins such as caesein were more effective than zein or gelatin for the growth of German roaches. Recently Noland *et al.* (1949b,c) described a purified synthetic diet for roaches which resulted in a growth rate at least equal to that obtained with the best crude diets tested. This diet was used in the present experiments, in which the levels and kind of protein were varied, supplements of certain amino acids were fed, and the biosynthesis of tryptophan and methionine demonstrated.

METHODS

Newly hatched nymphs of *Blattella germanica* (L.) were divided into groups of five to seven and reared in test-tube cages, Noland *et al.* (1949a) at 27°-32° C. Food and water were supplied *ad libitum* and renewed weekly. The insects were weighed after CO_2 anesthesia at 10, 20 and 30 days of age, and the age at maturation was recorded.

The control diet, "diet V," Noland *et al* (1949b, c), consisted of glucose (Cerelose) 31.4%, vitamin-free casein 30%, roughage (Cellu Flour) 30%, Wesson salts 4%, corn oil 3%, cholesterol 1%, and vitamin mixture 0.6%. The latter mixture supplied the following in γ/g of diet: choline Cl 4000, inositol 2000, nicotinic acid 100, Ca pantothenate 40, riboflavin 18, pyridoxine 18, thiamine 12, folic acid 5 and biotin 0.6. Changes in the casein content of the diet were made either at the expense of the carbohydrate or of the roughage; the amounts of casein ranged from 15 to 50% of the diet. Other proteins, or casein that had been oxidized, Toennies (1942) or hydrolyzed, Pearce *et al.* (1947) were fed at 15% of the diet.

Roaches fed some of the diets were analyzed for tryptophan and methionine by the microbiological method of Steele *et al.* (1949). Tryptophan was determined by the use of *Leuconostoc mesenteroides* P-60 and *Lactobacillus arabinosus* and methionine was determined by

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the use of *L. mesenteroides* and *Leuconostoc citrovorum* 8081. Prior to analysis the insects were starved for 48 hours. For the determination of tryptophan, samples weighing about 0.1 g. were chopped into test tubes containing 2 ml. of 4 N NaOH and the tubes sealed and autoclaved for 15 hours at 15 lb. pressure. The hydrolyzed samples were adjusted to pH 6.8 with HCl, diluted to 25 ml., filtered and stored in the refrigerator under toluene. Samples to be analyzed for methionine were autoclaved for 8 hours in 2 ml. of 4N HCl, and the pH adjusted to 6.8 with NaOH.

EXPERIMENTAL RESULTS

In spite of variations in carbohydrate or roughage, a dietary level of 40% of casein appeared to be optimal for growth and maturation (Table I). The other levels were effective in the decreasing order 30, 50, and 15% of dietary casein. The cellulose bulk material "Cellu

TABLE I

GROWTH AND MATURATION OF COCKROACHES FED SYNTHETIC DIETS CONTAINING VARIOUS LEVELS OF CASEIN

Exp. No.	Diet	Per Cent Casein in Diet	Per Cent Glucose in Diet	Weight at 30 Days	Age at Maturity	Survival
				mg	days	
D, E, F	V	15	46	30	44	10/10
C, D, E, F	V	30	31	43	40	15/15
C	V	40	21	58	37	6/6
D	V	50	11	40	44	6/6
C	VA*	40	51	46	40	4/6
C	VA*	50	41	40	44	6/6
C	VB**	42.8	45	45	37	5/6

* Roughage in diet V replaced by glucose.
** Roughage in diet V omitted, percentage of all other ingredients therefore increased.

Flour" did not appear to be an essential component of the diet, since its omission did not retard growth.

Ten commercial proteins fed in two experiments at 15% of synthetic diet V were effective in the following order (wts. at 30 days): crude fibrin 45, casein 30, steamed egg albumin 24, lactalbumin 22, wheat gluten 16, enzymatically hydrolyzed casein 10, zein 10, oxidized casein 10, gelatin 10 and hemoglobin 11. The average age at maturity varied from 40 days for roaches fed fibrin to 85 days for those fed hemoglobin. Most of the roaches fed gelatin or oxidized casein continued to grow slowly until maturity was reached, although these proteins are grossly inadequate for such animals as the rat and the chick.

The addition to casein of amino acids known to be more abundant in fibrin than in casein—tryptophan, arginine, cystine, glycine, and serine—failed to improve the growth rate. Furthermore, growth on crude fibrin was better than that on a highly purified preparation[3]

[3]We are indebted to Dr. P. R. Morrison of the Departments of Zoology and Physiology for this preparation.

from human blood, or on beef fibrin made low in ash by successive extractions with boiling ethanol, dilute acetic acid, and water. Apparently, therefore, factors other than amino acid composition were responsible for the good growth observed on crude fibrin. Minerals were considered in this connection since the salt mixture used, Wesson (1932) was one devised for vertebrates.

In three experiments an amino acid mixture simulating casein, Pearce *et al.* (1947) (DL amino acids at twice normal level) was fed at 30% of the diet. In a typical experiment roaches fed the amino acid mixture weighed 19 mg. at 30 days and they matured at 68 days as compared with 40 days for roaches fed casein.

Since roaches grew to maturity on such proteins as gelatin, zein and oxidized casein, which are deficient in one or more of the amino acids essential for higher animals, the tryptophan and methionine

TABLE II

TRYPTOPHAN AND METHIONINE CONTENT* OF YOUNG ROACHES AND OF ROACHES GROWN ON VARIOUS DIETS

Diet		Wt. 30 Days	Age at Maturity	Survival	Tryptophan	Methionine		
Protein	Supplement**				Lact. arab.	Leuc. mes.	Leuc. mes.	Leuc. citr.
		mg	days		mg/g	mg/g	mg/g	mg/g
Casein		58	37	3/4	1.25	1.26	2.07	2.32
Oxid. Casein		18	55	6/6	1.12	1.13	2.31	2.23
Oxid. Casein	+L-tryptophan	20	54	5/5	1.3	1.2	2.45	2.63
Oxid. Casein	+DL-methionine	24	55	5/5	1.14	1.14	2.91	3.67
Oxid. Casein	+L-tryptophan+ DL-methionine	44	43	5/5	1.38	1.41	3.42	4.15
2-day old nymphs		..	...	....	....	1.23	....	2.44

* All analyses expressed as mg/g live weight.

** 4.2 mg L-tryptophan/g diet; 19.8 mg DL-methionine/g diet; 1.4 mg L-cystine/g diet. These amounts were calculated to restore the amounts of these amino acids to those in a diet containing 15% of casein.

requirements were studied in greater detail. Oxidized casein, Toennies (1942) was fed at 15% of the diet, with supplements of L-tryptophan, DL-methionine, or both added at levels sufficient to supply the amount of the L-isomer normally present in the casein. Roaches fed oxidized casein at 15% of the diet required 55 days to mature as compared to only 37 days for roaches fed ordinary casein (Table II). The addition of L-tryptophan or DL-methionine singly did not improve growth, but the addition of both together resulted in almost normal growth. The further addition of cystine in one experiment retarded growth slightly.

Adult roaches which had matured on these diets were analyzed for tryptophan and methionine; nymphs of the same age as those used for the growth experiment were also analyzed. The concentration of tryptophan and methionine in the tissues was found to remain fairly constant regardless of age or of the tryptophan or methionine content of the diet. The newly hatched nymphs contained about 1.2 mg of

tryptophan and 2.5 mg. of methionine per g. of live weight. At the end of the experiment the adults previously fed oxidized casein contained 1.1 mg. of tryptophan and 2.3 mg. of methionine per g. live weight (Table II). Since the nymphs weighed only 2.0 mg as compared to an average weight of 62.7 mg. for the adults raised on the deficient diets, it follows that the amounts of tryptophan and methionine per roach had increased about thirty-fold on diets devoid of these amino acids.

There was, however, a wide variability in the growth rates of different individuals and groups fed the diets deficient in tryptophan and methionine. This suggested that intestional synthesis might be the source of the tryptophan and methionine accumulated by the insects. Accordingly, succinylsulfathiazole ("sulfasuxadine") was fed at a level of 1% in diets containing either casein or oxidized casein. Roaches fed the sulfa drug in addition to oxidized casein stopped growing at the age of 30 days and at 102 days of age they weighed only 5 mg.

TABLE III

EFFECT OF SULFASUXIDINE ON THE GROWTH OF COCKROACHES FED DIETS DEVOID OF TRYPTOPHAN OR METHIONINE

Protein	Supplement	Sulfasuxidine	Wt./roach		
			10 Days	20 Days	30 Days
	mg/g diet		mg	mg	mg
15% Casein	.....	...	5	14	25
" "	.....	1%	5	12	22
15% Oxid. Casein	.....	...	4	7	11.5
" " "	.....	1%	4	5	6
" " "	L-tryptophan 4.2	...	4	7	12
" " "	"	1%	4	4	4.5
" " "	DL-methionine 19.8	...	4	8	15
" " "	"	1%	5	8	12.5
" " "	L-tryptophan 4.2 + DL-methionine 19.8	...	5	16	30
" " "	"	1%	5	15	27

in contrast to 30 mg. for roaches fed oxidized casein alone. In a more extensive experiment 1% of sulfasuxidine was added to each of a series of diets containing casein, or oxidized casein with or without supplements of tryptophan or methionine. The addition of the sulfa drug to diets containing casein, oxidized casein supplemented with both amino acids, or supplemented with methionine alone did not greatly retard growth (Table III). However, the addition of sulfasuxidine to the two diets deficient in methionine resulted in complete cessation of growth.

DISCUSSION

The finding that the cockroach requires a level of protein roughly equal to that of carbohydrate conforms with the composition of the

synthetic diets which have been used by Fraenkel for various species of grain beetles. The observation that roaches grow slowly but mature on incomplete proteins such as gelatin, zein, or oxidized casein is in accord with the earlier results of Zabinski and McCay. Apparently the rate of growth on such diets is determined by the rate at which tryptophan and methionine become available to the insect. House (1949) has concluded that tryptophan, but not methionine, is essential for the growth and reproduction of cockroaches reared aseptically. In his experiments, however, aseptic roaches fed both tryptophan and methionine grew at a slower rate than that of our deficient roaches (Table II). In our experiments both amino acids were essential for rapid growth, while in the presence of sulfasuxidine methionine appeared to be the more essential of the two. Apparently methionine can be synthesized by intestinal microorganisms while tryptophan may be synthesized by other means, perhaps by intracellular symbionts or within the tissues of the insect.

SUMMARY

The relative activities of various proteins for growth of the roach were fibrin and casein, good; steamed egg albumin, lactalbumin and wheat gluten, fair; and enzymatically hydrolyzed casein, zein, oxidized casein, gelatin and hemoglobin, poor.

Roaches reared to maturity on oxidized casein, which is deficient in both tryptophan and methionine, nevertheless accumulated normal quantities of both amino acids in their tissues. Growth in the absence of dietary methionine could be suppressed by the feeding of 1% sulfasuxidine.

LITERATURE CITED

House, H. L. 1949. Nutritional studies with *Blatella germanica* (L.) reared under aseptic conditions III. Five essential amino acids. Canadian Entom. 81: 133.

McCay, C. M. 1938. The nutritional requirements of *Blatella germanica*. Physiol. Zool. 11: 89.

Noland, J. L., Lilly, J. H., and **Baumann, C. A.** 1949a. A laboratory method for rearing cockroaches, and its application to dietary studies on the German roach. Ann. Ent. Soc. Amer. 42: 63.

1949b. Vitamin requirements of the cockroach *Blatella germanica* (L.). Ann. Ent. Soc. Amer. 42: 154.

Noland, J. L., and **Baumann, C. A.** 1949c. Requirement of the German cockroach for choline and related compounds. Proc. Soc. Exp. Biol. Med. 70: 437.

Pearce, E. L., Sauberlich, H. E., and **Baumann, C. A.** 1947. Amino acids excreted by mice fed incomplete proteins. J. Biol. Chem. 168: 271.

Steele, B. F., Sauberlich, H. E., Reynolds, M. S., and **Baumann, C. A.** 1949. Media for *Leuconostoc mesenteroides* P-60 and *Leuconostoc citrovorum* 8081. J. Biol. Chem. 177: 533.

Toennies, G. 1942. The oxidative conversion of casein into protein free of methionine and tryptophane. J. Biol. Chem. 145: 667.

Wesson, L. G. 1932. A modification of the Osborne-Mendel salt mixture containing only inorganic constituents. Science 75: 339.

Zabinsky, J. 1928a. Rearing cockroaches on an artificial diet. Compt. Rend. Soc. Biol. 98: 73.

1928b. Recent experiments with the rearing of cockroaches on an artificial diet. Effect of dietary composition. Compt. Rend. Soc. Biol. 98: 78.

1929. The growth of blackbeetles and of cockroaches on artificial and on incomplete diets. Part I. Brit. J. Exp. Biol. 6: 360.

TWO RARE AND CLOSELY RELATED APHIDS FROM AUSTRALIA AND CHINA

(Hemiptera, Aphididae)

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Anomalaphis comperei Pergande

(Figure 1)

Alate parthenogenetic viviparous female.—Ground color probably greenish overlaid with black pigmented areas and shiny black thoracic muscular region. Body normal in shape with small spatulate setae and a few hairs posteriorly. Length, 1.75 mm. Head, normal, dusky. Ocelli raised on short cones. Compound eyes with tubercle, the median ocellus distant from the other two. Rostrum slender, extends to third coxae. Antennae short, dark, 5-segmented, with few short knobbed hairs lying almost flat against surface; imbricated; secondary sensoria circular; distributed as follows: III, 5–8 on the apical half; IV, 1–4. Permanent sensory compound as illustrated. Lengths of segments: I, 0.17 mm.; II, 0.21 mm.; III, 0.30 mm.; IV, 0.16 mm.; V, 0.25 mm. (base, 0.15 mm. + spur, 0.10 mm.). Prothoracic tubercles prominent, cone-shaped. Legs normal with few hairs. Wings with clouded veins. Primary pair longer than body, 2.27 mm.; secondary pair, 0.73 mm.; radial sector only slightly curved; media 1-branched; cubitus and anal as usual; stigma distinct. Hind wings poorly developed, not extending to the tip of the anal of the forewing; with only radial sector; hamuli well developed. Abdomen marked with black spots, and irregular patches. Setae short, spatulate or knobbed and arising from dark areas. A light transverse band in front of cornicles and other non-pigmented areas as indicated in the figure. Spiracles on tubercles. Cornicles unique, except in the related genus *Anomalosiphum* described elsewhere in this article. They are black, relatively short, 0.17 mm. in length, cylindrical, enlarged just before and then sharply constricted to the flanged opening. At the largest diameter there are 4 prominent curved spines which may be enlarged apically in the nymphs. The apical constricted area is somewhat reticulated. On the dorsal median areas of abdominal segments VII and VIII, and posterior to the cornicles, are two pairs of prominent, black, slender imbricated and pointed tubercles—the shorter pair directly anterior to the larger hind pair. These tubercles may attain a length of 0.32 mm. They terminate in slender knobbed or hand-like enlargements which are specially prominent in the nymphs and apterous forms. The cauda is shallow, crescent-shaped, broad and supports curved hairs.

Apterous parthenogenetic viviparous female.—Almost wholly dusky or black with lighter and darker areas as indicated in Figure 1. The body setae and the lateral tubercles are much more prominent than in the alates. Other characters as illustrated. Length of body 1.50

mm.; antennae 0.73 mm.; rostrum 0.52 mm.; cornicle, 0.13 mm.; body setae or spines 0.22 mm.; antennal segments III, 0.24 mm.; IV, 0.12 mm.; V, 0.19 mm. (base, 0.11 mm. + spur, 0.08 mm.). Secondary sensoria are distributed as follows: 1–2 on III, and 1–2 on IV. The permanent sensoria are as in the alates.

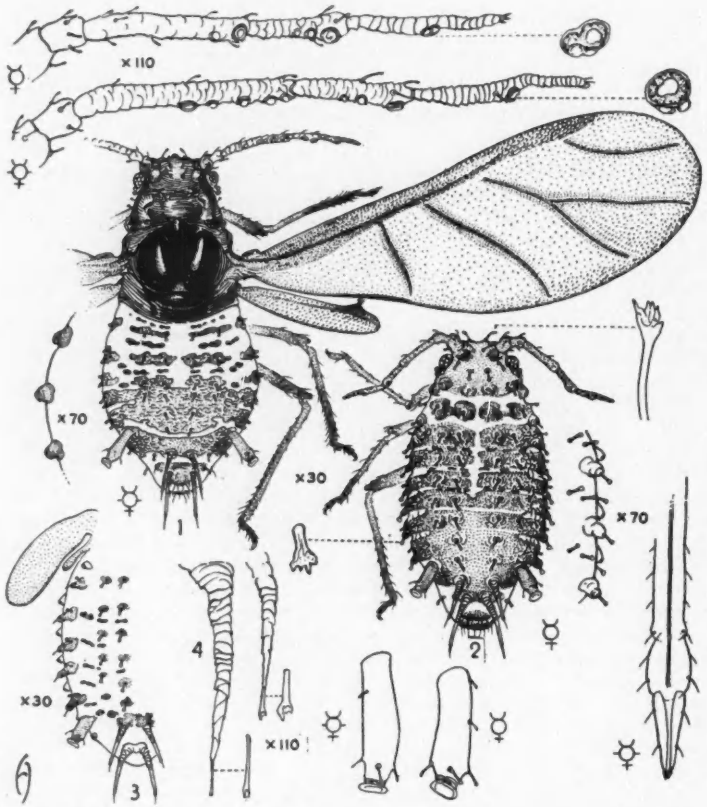


FIG. 1. *Anomalaphis comperei* Pergande. 1, adult alate parthenogenetic viviparous female; 2, apterous female; 3, portion of dorsum of abdomen of immature alate; 4, the posterior dorsal abdominal tubercles of the apterae. The antennae and cornicles are of the apterous female (top) and alate female (next below). Rostrum and other characters are enlarged as indicated. (Drawing by Frieda Abernathy.)

All specimens were collected by P. N. Forte on *Agonus flexuosa* at Albany, Western Australia, December 17, 1948, and February 1949. They are designated as topotypes.

HISTORICAL ACCOUNT

In November 1923 I had the first opportunity to look over the collection of Aphididae of the United States Department of Agriculture, Bureau of Entomology, and among other wonders P. W. Mason showed me the original specimens of this species. They were so different from any I had ever seen that I resolved to get specimens direct from Australia if possible. My early first attempts were futile and it was not until May 25, 1948, following the suggestion of H. G. Andrewartha, Entomologist, Waite Research Institute, Adelaide, South Australia, I wrote

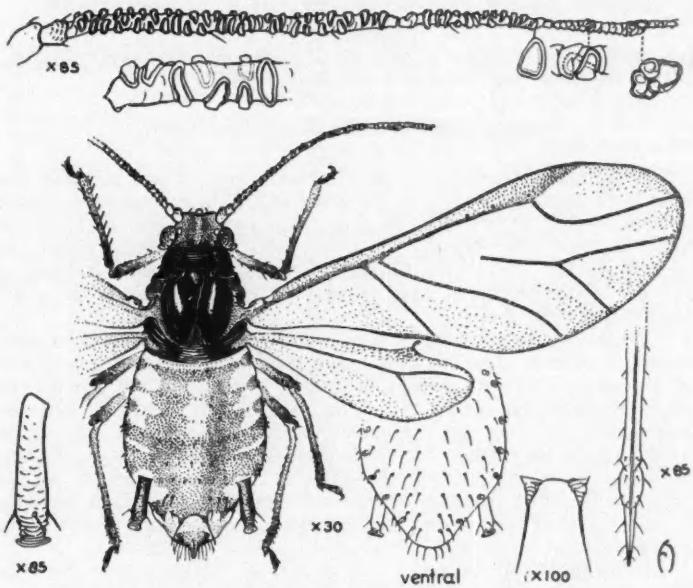


FIG. 2. *Anomalosiphum pithecolobii* Takahashi. Alate viviparous parthenogenetic female and enlarged details of various structures including a portion of the ventral surface of the abdomen. Enlargements are indicated. (Drawing by Frieda Abernathy.)

to C. F. H. Jenkins, Government Entomologist, Department of Agriculture, Perth, Western Australia for specimens of any aphids on eucalyptus. On January 14, 1949, Mr. Jenkins sent me a generous lot of an unknown species in alcohol, collected at his request by P. N. Forte on *Agonis flexuosa* (*Leptospermum*), a native tree at Albany, Western Australia, December 17, 1948. These proved to be the desired species, *Anomalaphis comperei* Pergande. This was only the second time that the aphid was collected 47 years after Compere's discovery in the same general locality but on a different host plant. Since this lot contained but a single alate an additional and much larger collection was made in

the same locality and on the same host plant in February 1949. Altogether approximately 307 specimens including young in all stages and adult apterae and alatae were studied. These were all mounted on 35 slides and designated as topotypes. Mounted specimens were distributed to certain aphidologists and to the British Museum of Natural History (which proved to be the first), the United States National Museum, and the California Academy of Sciences.

The original specimens were collected by George Compere on *Eucalyptus* and *Acacia* along the beach at Albany, Western Australia in 1901.

The genus *Anomalaphis* was described by A. C. Baker (1920).

REFERENCE

Baker, A. C. 1920. Generic classification of the hemipterous family Aphididae. U. S. Dept. Agr. Prof. Paper, Bul. 826: 52–53, Pl. VIII, D-F.

Anomalosiphum pithecolobii Takahashi

(Figure 2)

A single alate specimen of this interesting species was received in a mixed lot collected on the insect survey of the Metasequoia or Dawn Redwood region at Siu Ho, Liechuen (Lichwan ?) Hupeh Province, China, in September by W. Y. Djou, who was working under the direction of Dr. J. Linsley Gressitt for the California Academy of Sciences. No host plants were given for the miscellaneous lot which included this individual.

This species showed such close relationships with *Anomalaphis comperei* Pergande, that I at first glance thought it was that species and that it had somehow come from Australian specimens I happened to be mounting about the same time. The resemblance had to do with the 5-segmented antennae and particularly with the wing venation and the peculiar cornicles which are almost identical. The most striking differences between the Chinese and the Australian species are the numerous crowded irregular transverse secondary antennal sensoria, the single pair of post abdominal tubercles, the presence of the media vein in the hind wings, and the pointed cauda of the former.

Takahashi (1934) collected this species at Shinten near Taihoku, Foromsa on the legume, *Pithecellobium* (*Pithecolobium*) *lucidum*, a plant closely related to Manila tamarind, *P. arboreum*, catclaw or blackbead, *P. unguiscati* and other species belonging to the new and old worlds.

The close relationships between these two genera and species would indicate some affinities between the Southeast China fauna and that of Western Australia, if we are to consider *Anomalaphis* to be native of the latter country which indeed seems quite likely.

REFERENCE

Takahashi, R. 1934. Two new genera of Aphididae (Hemiptera). Stylops 3(3): 54–56, fig. 1.

SEASONAL VARIATION IN THE ADULT SIZE OF PACHYDIPLAX LONGIPENNIS (BURMEISTER) (Odonata, Libellulidae)[1]

GEORGE HENRY PENN
Tulane University, New Orleans

For several years it has been apparent that adults of *Pachydiplax longipennis* (Burmeister) normally exhibit a considerable range in size throughout their eight month flying season in the Gulf coast area. The extent of these variations and the reasons for them have remained unknown. A search of the literature indicates that other entomologists have noted the same phenomenon. Calvert (1893, 1901–08), Kellicott (1890), and Wright (1937) all called attention to this great size variation in *Pachydiplax* adults, and Wright (1943) attempted to base the reasons for it in the Gulf coastal marshes on either "the effect of the saline variation upon the nymphs or to a variation in food abundance."

With the aim of learning more about the phenomenon a study of size variations was undertaken utilizing the large series of adults available in the Tulane collections. Lengths of fore and hind wings, widths of all four wings at their widest points, length of abdomen, sex, age (as indicated by the color of each individual), and date and locality of collection were thus recorded for 368 specimens (201 males, 167 females) from Louisiana, Mississippi and Alabama.[2]

Specimens examined were collected in the following localities (numbers in parentheses are Tulane numbers): LOUISIANA. ALLEN PARISH: 4 mi.w. Oberlin (421). ASSUMPTION PARISH: Attakapas Landing (1517). AVOYELLES Parish: 2 mi. s. Marksville (434). BOSSIER PARISH: Benton (1414). CADDO PARISH: Shreveport (1397), 10 mi. w. Shreveport (1399). DE SOTO PARISH: Frierson (1436), Keatchie (1395), Logansport (1392), Naborton (1441), Pelican (1386). JEFFERSON PARISH: Bayou Villars (P. 465), Bridgedale (602), Bucktown (612), Metairie (1072, 1088), Waggaman (271, 1265, 1351), Willswood (383). LAFAYETTE PARISH: Lafayette (1019, 1022, 1026–28, 1486–94, 1496–97), Youngsville (1020, 1495). LAFOURCHE PARISH: Raceland (384), Roux (P. 438). LIVINGSTON PARISH: Springfield (765). ORLEANS PARISH: New Orleans (40 lots from various parts of the city including earliest and latest seasonal records: March 10, 1949 and October 27, 1948). PLAQUEMINES PARISH: Boothville (1079), Delta National Wildlife Refuge (953), Fort Jackson (P. 426), Oak River (P. 442), Phoenix (1508), Port Sulfur (P. 471). RAPIDES PARISH: Zimmerman (1360). SABINE

[1]A contribution from the Department of Zoology of the Tulane University of Louisiana; one of a series of reports resulting from researches on *Mosquitoes and Other Aquatic Insects* supported by the University Council on Research of Tulane University.

[2]I am indebted to Mr. Leonard W. Willis, a student, who made many of these measurements.

PARISH: Zwolle (1381). ST. BERNARD PARISH: Yscloskey (P. 468). ST. CHARLES PARISH: 1 mi.n. Boutte (998). ST. LANDRY PARISH: 7 mi.nw. Washington (419). ST. MARY PARISH: 5 mi.w. Baldwin (107). ST. TAMMANY PARISH: 3 mi.s. Abita Springs (462), 2 mi.w. Bush (735), Covington (641, 783, 1227), Fontainebleau State Park (738), Honey Island (P. 445), Indian Village (1566), 1 mi. ne. Lacombe (465), 2 mi.s. Madisonville (795); 2 mi.n. Pearl River (1584), St. Tammany (463, 468, 615, 1219), Slidell (P. 460, 642, 1065), St. Joe, (1582), 1 mi.s. Sun (748). TANGIPAHOA PARISH: 5 mi.e. Ponchatoula (114), 4 mi.e. Ponchatoula Beach (759), Robert (718). WASHINGTON PARISH: 1 mi.s. Rio (750), 3 mi.e. Varnado (400, 404). WEBSTER PARISH: Springhill (1425). MISSISSIPPI. COVINGTON COUNTY: 9 mi.e. Prentiss (388), Lonestar

TABLE I

RANGE OF MEASUREMENTS OF ADULT *Pachydiplax longipennis*

	LENGTHS IN MILLIMETERS				Locality	Authority
	Maximum		Minimum			
	Male	Female	Male	Female		
Hind wing	33.5	32.0	23.0	28.0	Phila.	Calvert '93
" "	33.0	31.0	25.0	25.0	Ohio	Kellicott, '99
" "	34.5	.....	23.0	.....	Texas	Calvert, '01–'08
" "	.....	32.5	.....	25.0	Mexico	" "
" "	33.0	.....	25.0	.....	Georgia	" "
" "	32.3	31.6	23.4	24.0	La. and Miss.	Present study
Fore wing	35.0	42.0	28.0	30.0	Gulf Coast	Wright, '43
" "	35.3	34.3	24.5	25.2	La. and Miss.	Present study
Abdomen	28.0	25.0	20.0	20.5	Phila.	Calvert, '93
"	29.0	24.0	20.0	18.0	Ohio	Kellicott, '99
"	29.0	25.0	20.0	18.0	Texas	Calvert, '01–'08
"	26.0	.....	22.0	.....	Georgia	" "
"	29.2	26.1	20.0	17.6	La. and Miss.	Present study

(389), 8 mi.s. Mt. Olive (390). GEORGE COUNTY: Lucedale (1245). HANCOCK COUNTY: 2 mi.ne. Pearlington (607), Pearl River at US 90 (637), 3 mi.n. Pearlington (638), 4 mi.n. Gainesville (639), 10 mi.e. Pearlington (649), 10 mi.e. Picayune (306), 5 mi.s. Kiln (650), Kiln (651), Santa Rosa (655). HARRSION COUNTY: Biloxi (1036), Saucier (1095), 16 mi.e. Saucier (1235), DeLisle (1252), Pass Christian (1251). JACKSON COUNTY: 1 mi.e. Orange Grove (1239). JEFFERSON DAVIS COUNTY: Prentiss (625), 8 mi.e. Prentiss (385, 386, 626), White Sand (624). LAFAYETTE COUNTY: Oxford and vicinity (P. 205, P. 207, P. 209, P. 214, P. 218, 357, 358). LEE COUNTY: Guntown (1550). MONROE COUNTY: 2 mi. n. Aberdeen (1553). OKTIBBEHA COUNTY:

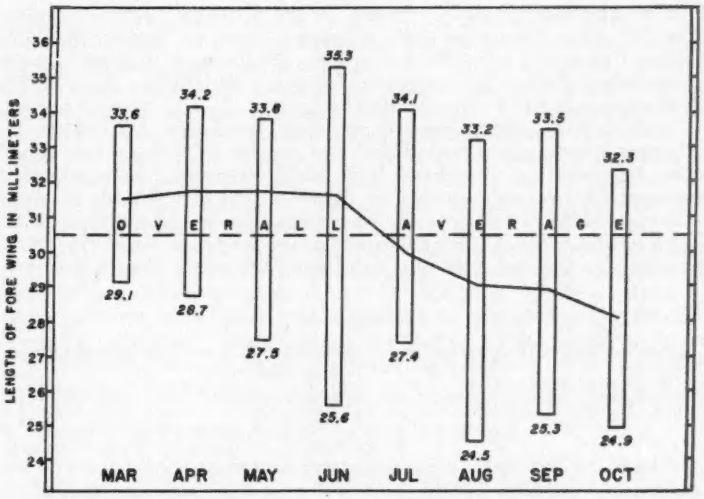


FIG. 1. Seasonal variation in length of fore wing of adult *Pachydiplax longipennis:* vertical bars represent range of monthly extremes; solid black line represents monthly averages.

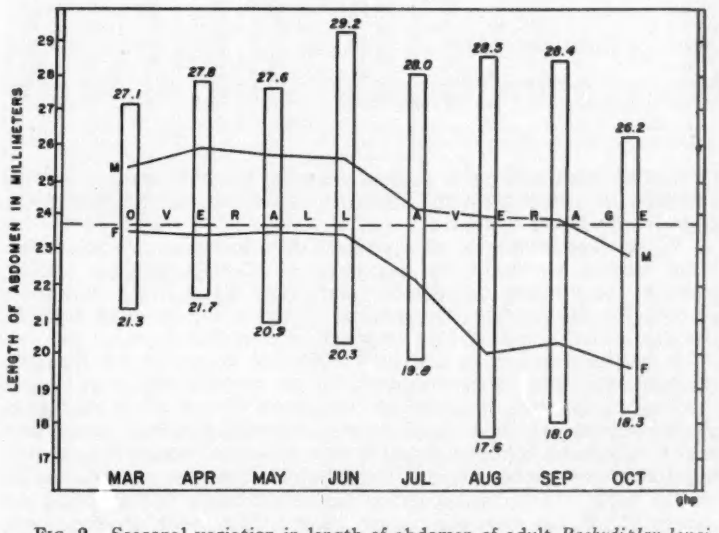


FIG. 2. Seasonal variation in length of abdomen of adult *Pachydiplax longipennis:* vertical bars represent range of monthly extremes; solid black lines represent monthly averages, M-M the males, F-F the females.

7 mi.e. Mathiston (1554). PEARL RIVER COUNTY: 2 mi.n. McNeil (654), 6 mi.n. Picayune (640). STONE COUNTY: Perkinston (700). TIPPAH COUNTY: 2 mi.e. Walnut (1546). WILKINSON COUNTY: 4 mi.w. Centerville (580). YALOBUSHA COUNTY: (P. 217). ALABAMA. TUSCALOOSA COUNTY: Tuscaloosa (1527).

Although the measurements of these specimens fall within the extremes previously reported for the species (Table I) the results when tabulated on a seasonal basis yield interesting data previously unsuspected. An examination of figures 1 and 2 and table II shows that apparently in this area the adults emerging in the first half of the flying season (March through June) are considerably larger than those emerging in the last half (July through October). That there is no

TABLE II

SEASONAL RANGE OF AVERAGE MEASUREMENTS, SEX RATIO AND APPARENT AGE OF ADULT *Pachydiplax longipennis*

Month	Number Exam.	Sex Ratio ♂/100 ♀	Average Forewing Length	Average Abdomen Length		Percent Turned Black or Pruinose		
				♂	♀	♂	♀	Total
Mar.	33	107	31.5 mm	25.4	23.5	17	7	15
Apr.	83	92	31.7	25.9	23.4	83	7	43
May	34	42	31.7	25.8	23.5	90	12	35
June	39	158	31.6	25.7	23.4	92	34	70
July	56	80	30.0	24.1	22.1	92	7	43
Aug.	56	175	29.0	23.9	20.0	97	14	66
Sept.	34	312	28.9	23.8	20.3	100	34	89
Oct.	33	230	28.1	22.8	19.6	100	23	75

correlation with locality is obvious knowing that the specimens were collected in widely scattered localities in two states throughout the eight-month flying season.

While these facts seem clearly established, unfortunately the underlying reasons for them are not obvious. Certain possible factors, however, bear closer examination and invite speculation: abundance of food for the nymphs, temperature of the water in which nymphs developed, and length of time required for nymphal development.

It has been shown by Calvert (1929) that starvation of dragonfly nymphs may result in decreased size of the nymphs and a consequent increase in the time required for completion of the life cycle. It is readily apparent upon examination of the nymphal habitats in this area that food suitable for the nymphs is most abundant during the warmest months of the summer when *P. longipennis* is our most common species on the wing. Water temperature during this same period would not exceed 95° F. on even the hottest days. Thus, with an abundance of food and a warm temperature it would seem logical that dragonfly nymphs could complete their life cycles in the shortest possible time

during the summer, and this is probably the case with *P. longipennis*. Unfortunately we have no estimation of the time normally required by this species under optimum conditions, but another libelluline common in this area, (*Erythemis simplicicollis* (Say), was reared from egg to adult in the laboratory in 113 days by Bick (1941). I would guess that *Pachydiplax longipennis* would approximate this time if not better it.

On the other hand, those nymphs emerging from eggs laid late in the summer and consequently developing during the fall and winter would enjoy less optimum conditions and completions of their life cycles would not be so rapid.

If the above speculations are true the phenomenon of seasonal variation of adult size of *P. longipennis* may resolve itself into another manifestation of the so-called "Law of Standfuss" (1896). That is, "the longer the time of development the greater the adult size attained." Heretofore this "law" has been applied mainly to the Lepidoptera on an interspecific level. This would be the first application on an intraspecific level. It would be enlightening to compare the data presented here with data from a similar study in a more northerly latitude where the ratio of warm months to cold months is reversed.

LITERATURE CITED

Bick, George H. 1941. Life-history of the dragonfly, *Erythemis simplicicollis* (Say). Ann. Ent. Soc. Amer., 34: 215–230.

Calvert, Philip P. 1893. Catalogue of the Odonata (dragonflies) of the vicinity of Philadelphia, with an introduction to the study of this group of insects. Trans. Amer. Ent. Soc., 20: 152–272.

1901–1908. Odonata. *In* Biologia Centrali-Americana, Neuroptera, pp. 17–420.

1929. Different rates of growth among animals with special reference to the Odonata. Proc. Amer. Philos. Soc., 68: 227–274.

Kellicott, David S. 1899. The Odonata of Ohio. Ohio State Acad. Sci., Spec. Pap. no. 2, pp. 1–114.

Standfuss, M. 1896. Handbuch der palaearktischen Grossschmetterlinge. Jena. (As quoted by **Martin Hering,** 1926. Biologie der Schmetterlinge. Berlin: Julius Springer, pp. 259–260.)

Wright, Mike. 1937. A survey of the adult anisopterous dragonflies of the central Gulf Coast region. Jour. Tennessee Acad. Sci., 12: 255–266.

1943. A comparison of the dragonfly fauna of the lower delta of the Mississippi River with that of the marshes of the central Gulf Coast. Ecol. Monogr., 13: 481–497.

ERRATA

In the article, "Notes on the Simuliidae (Diptera) of Guatemala, including descriptions of three new species," by Herbert T. Dalmat, vol. 44, pp. 31–58, the following corrections should be made. On page 54, "*S.* (*D.*) *delatorrei*" should read "*S.* (*H.*) *delatorrei;*" on page 55, "*S.* (*S.*) *microbranchium*" should read "*S.* (*H.*) *microbranchium,*" and "*S.* (*S.*) *samboni*" should read "*S.* (*L.*) *samboni.*"

A NEW GENUS AND TWO NEW SPECIES OF DELPHACINE FULGORIDS

(Homoptera, Fulgoridae, Delphacinae)

R. H. BEAMER[1]

Pareuidella, new genus

Resembling *Euidella* but crown about one-third longer than basal width, narrowing toward apex and diaphragm with an avicephaliform brace just ventrad of aedeagal shaft.

Pareuidella spatulata n. sp., type of the genus.

Pareuidella spatulata n. sp.

Brachypterous form.—Resembling *Euidella weedi* (Van D.) but smaller, usually lighter in color, with styles of males spatulate, anal segment with a pair of long processes and aedeagus with a pair of very long caudoventrally projecting movable processes. Length ♂, 2.3 mm.; ♀, 2.7 mm.

Structure: Front almost twice as long as greatest width, widest on apical third, slightly more than half as wide at base as at apex, strongly tricarinate; crown about one-fourth longer than basal width, distinctly carinate; elytra reaching to about middle of abdomen, semihyaline, veins raised, apices truncate.

Color: General color stramineous, styles black on outer half.

Genitalia: In lateral view, anal segment with a pair of slender processes about as long as segment and extending at right angles to it; aedeagus almost straight, tapering slightly to sharp apex, dorsal margin of outer third with about nine short heavy teeth; aedeagal brace produced into a pair of ventrally curving sharp-pointed processes almost as long as aedeagus; styles enlarged from base to apices, sides and apices sinuate. In caudal view, styles enlarged from base to apices, generally curved slightly in, apices more or less bifid, inner part slightly blunter and broader, aedeagal brace a pair of long sharp, pointed processes with apices slightly diverging.

Types.—*Holotype* ♂, *allotype* ♀, 37 ♂ and 36 ♀ *paratypes*, Thomasville, Ga., June 30, 1940, R. H. Beamer; other *paratypes:* 6 ♂♂ and 8 ♀♀, Chapel Hill, N. C., Aug. 31, 1936, R. H. Beamer; 2 ♂♂ and 1 ♀, same place and date, L. D. Beamer; 1 ♂, Raleigh, N. C., Oct. 16, 1938, P. W. Oman.

Macropterous form.—Like the brachypterous form except with wings about one-third their length longer than the abdomen and at least in some cases slightly darker in general color.

Holomorphotype ♂, *allomorphotype* ♀ and 1 ♂ *paramorphotype*, Thomasville, Ga., June 30, 1948, R. H. Beamer; other *paramorphotypes:*

[1]Contribution No. 752 from the Department of Entomology, University of Kansas.

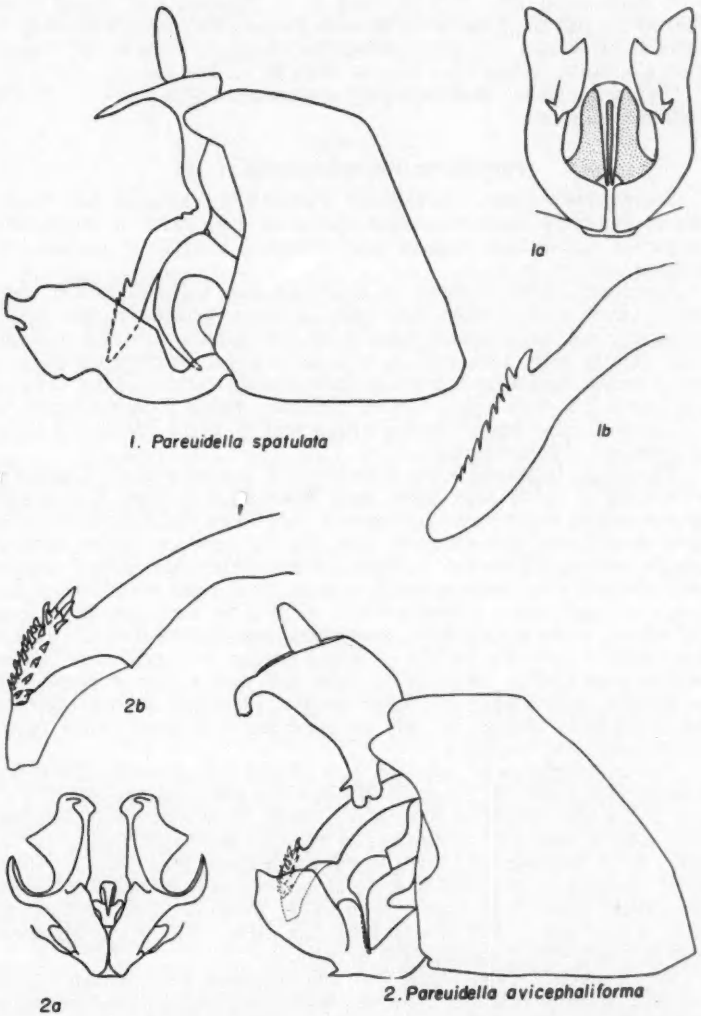


FIG. 1. *Pareuidella spatulata*, lateral view of genital capsule; 1a, caudal view of styles and aedeagal brace; 1b, aedeagus in lateral view, enlarged. FIG. 2. *Pareuidella avicephaliforma*, lateral view of genital capsule; 2a, caudal view of styles and aedeagal brace; 2b, aedeagus in lateral view, enlarged.

1 ♂, Homestead, Fla., July 20, 1948, R. H. Beamer; 1 ♂, Royal Palm Park, Fla., July 21, 1948, R. H. Beamer; 1 pair, Ft. Pierce, Fla., Aug. 7, 1930, P. W. Oman, 1 ♀, Fruitville, Fla., Aug. 11, 1930, P. W. Oman, 1 ♂, Cocoanut Grove, Fla., Aug. 9, 1930, R. H. Beamer.

Types in Snow Entomological Collection. Paratypes in U. S. National Museum.

Pareuidella avicephaliforma n. sp.

Macropterous form.—Resembles *Pareuidella spatulata* but much larger, generally darker in color and male style with a thumb-like projection on outside margin near middle. Length ♂ 4 mm., ♀ 4.8 mm.

Structure: First segment of antennae just slightly shorter than second; front slightly more than twice as long as greatest width, widest on apical half, sides almost parallel in this region, narrowed to base, base slightly more than half as wide as at apex, strongly tricarinate; crown longer than wide, tapered to apex, carinae distinct; elytra extending almost half their length beyond abdomen, widest on outer fourth.

Color: General smoky brown with a spot on tip of clavus and veins of outer half of wings darker.

Genitalia: In lateral view, pygofer with posterior margin concave with angular point near base; anal segment with pair of rounded projections on outer corner and pair of very short sharp teeth on outer basal corner; aedeagus widest at base, slightly curved ventrally, ventral margin with broad angular enlargement near outer third, dorsal margin with about 10 sharp retrorse teeth on outer third, apex sharp avicephaliform; aedeagal brace avicephaliform, as long as aedeagus, beak long and sharp; styles enlarged on outer two-thirds, curved dorsally with a large blunt notch near middle of dorsal margin; in caudal view, styles bent in near middle, spatulate on outer half with a narrow thumb-like projection near middle of outer margin; aedeagal ventral process avicephaliform, almost as long as aedeagus and much same form, not divided as in *spatulata*.

Types.—*Holotype* ♂, *allotype* ♀, 8 ♂ and 9 ♀ *paratypes*, Suwanee Springs, Fla., July 3, 1948, R. H. Beamer; other paratypes, 2 ♂♂ and 3 ♀ ♀, New Smyrna, Fla., May 1, 1943, M. Wright; 1 ♂, Sebring, Fla., Aug. 5, 1930, R. H. Beamer; 2 ♂♂, Lake Placid, Fla., July 13, 1948, B. T. McDermott; 1 ♂, Royal Palm Park, Fla., July 21, 1948, R. H. Beamer; 3 ♂♂ and 5 ♀ ♀, Morrison Field, West Palm Beach, Fla., 1942, Elmo D. Hardy; 1 ♂ and 1 ♀, Fruitville, Fla., J. Nottingham; 3 ♂♂ and 2 ♀ ♀, Camp Polk, La., May, 1945, K. L. Maehler; 1 ♂, Sanford, Fla., June 22, 1931, at light.

Brachypterous form.—Like the macropterous form except elytra reaching to about middle of abdomen with truncate apices and generally lighter in color.

Holomorphotype ♂, *allomorphotype* ♀ and 1 ♀ *paramorphotype*, Okefenokee Swamp, Ga., July 30, 1934, R. H. Beamer.

Types in Snow Entomological Collection and paratypes in Ohio State University Collection.

LONGICORN BEETLES FROM NEW GUINEA AND THE SOUTH PACIFIC

(Coleoptera: Cerambycidae)[1]

PART II

J. LINSLEY GRESSITT
Lingnan University, Canton, China

This second installment[2] concerns species of the subfamily Cerambycinae principally from New Guinea, the Moluccas and the Solomon Islands. The material here reported upon is from the California Academy of Sciences in San Francisco (C.A.S.), the American Museum of Natural History in New York (A.M.N.H.), the Hawaiian Sugar Planters' Association Experiment Station in Honolulu (H.S.P.A.) and the Taiwan Agriculture Research Institute in Taipeh, Formosa. Certain paratypes are deposited in the Chicago Natural History Museum and the Lingnan Natural History Museum. The materials here reported upon was collected by K. S. Hagen and R. Peters in addition to those listed in the introduction to Part I.

Subfamily **Cerambycinae** (continued)

Tribe **Molorchini** (continued)

52. **Leptepania sulcicollis,** new species

Fig. 7

Male.—Reddish brown, rather glossy; darker on pronotum, femoral clubs, tibiae and sides of abdomen, paler on antennae and femoral peduncles. Body with fine erect palish hairs, longest on antennae and pronotum.

Head slightly narrower than prothorax; frons trapeziform, broadly and shallowly reticulate; vertex barely concave, less distinctly reticulate; eye divided, inferior lobe surrounded. Antennae fully three-fourths as long as body; third to tenth segments thickened apically; scape thickened beyond middle; third segment slightly longer than fourth and shorter than fifth; sixth to tenth gradually decreasing in length; last thickest near middle, slender distally. Prothorax about twice as long as broad, narrowest at pre-basal constriction, much narrower at base than anterior to constriction, subparallel anterior to pre-basal constriction, except for slight narrowing at extreme apex and a slight constriction just behind middle, above lateral cavities, which are deep, hairy and one-third as long as prothorax; surface broadly and shallowly reticulate, with a median groove along nearly basal half of median line

[1]Joint contribution from the California Academy of Sciences and the Lingnan Natural History Survey and Museum, Lingnan University.

[2]For Part I, see Ann. Ent. Soc. Amer. 44(1): 1-30, 1951.

of disc. Scutellum short and rounded behind. Elytra barely reaching to level of middle of hind coxae, less than one-half as long as abdomen, dehiscent in apical quarter; each narrowed and rounded apically, with small irregular punctures on basal portion and a few larger punctures near apex. Ventral surfaces smooth, rather sparsely, but distinctly, punctured. Each femur suddenly and strongly clavate, and shiny, for slightly more than distal half; tibiae opaque, slightly curved; tarsi long. Length 4.35 mm.; breadth 0.62.

Holotype, male (C.A.S.) Hollandia, northern New Guinea, April 16, 1945, S. G. Jewett; *paratopotype*, male, same data.

Differs from *L. longicollis* (Heller), of Luzon in being much smaller, with the elytral bases dark, and from *L. minuta* Gress., of Formosa, in being slightly larger, in having the pale marking of the elytra in form of a transverse band on second quarter widened at suture, instead of narrowed at suture to form a triangle on each, and in having the prothorax constricted slightly at lateral cavities.

Tribe **Callichromini**

53. **Chloridolum distinctum** Pascoe, 1869

One (C.A.S.) Maffin Bay, NW. New Guinea, Sept. 10, 1944, E. S. Ross.

54. **Chloridolum dorycum** (Boisduval), 1835

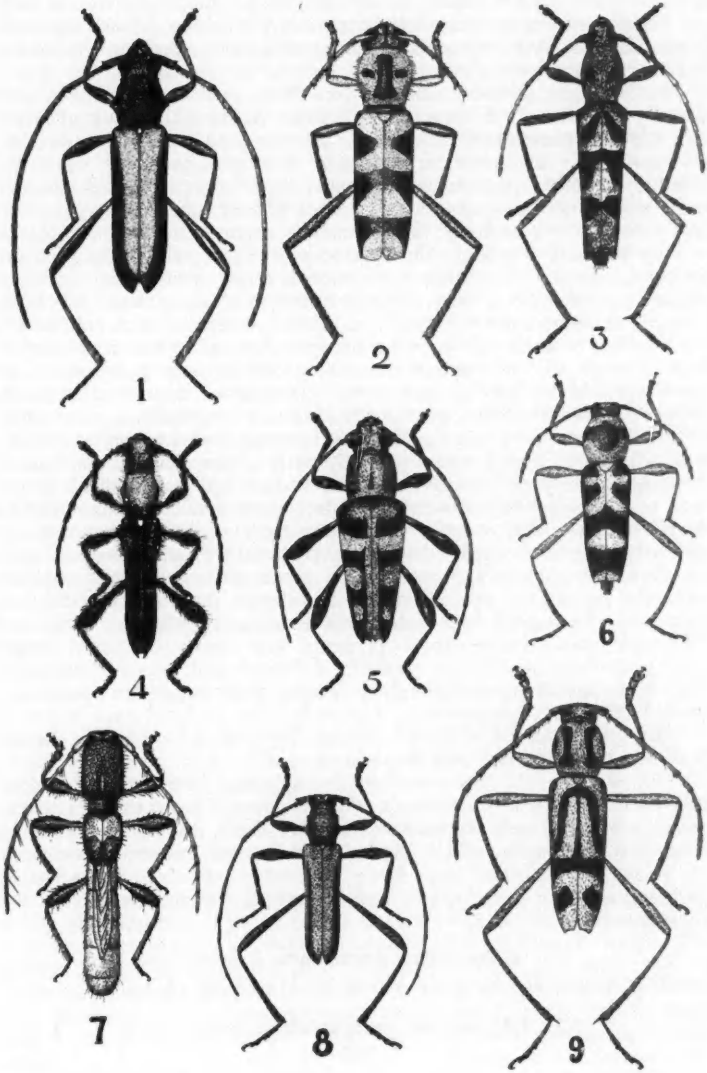
Several (C.A.S.), Hollandia, northern New Guinea, Dec. 24, 1944, Harry Hoogstraal; one (A.M.N.H.) New Guinea, Jan. 1928, from collection of J. G. Thorndike.

55. **Chloridolum papuanum,** new species

Male.—Golden green to bluish black and red: head shiny iridescent golden green tinged with bronzy black; mandibles bluish basally, pitchy black apically; rest of mouthparts ochraceous; antennae steel blue, blue-black apically and bronzy greenish on scape; prothorax iridescent golden green, brilliant golden coppery green on sides of disc and on under surface, duller bluish green on punctured pubescent area on each side of median line of disc, reddish on extreme anterior and posterior borders; scutellum shiny golden green; elytra largely of a relatively dull purplish to bluish black, largely dull along suture, each with a moderately broad submedian stripe of pale golden green mixed with testaceous and bearing fine oblique or subtransverse adpressed pale hairs, but more greenish and metallic at base and apex, and reaching suture just before apex; ventral surfaces pale golden green, tinged with orange in part, clothed with fine silvery pubescence, black on posterior borders of abdominal segments, largely orange on

EXPLANATION OF PLATE I

FIG. 1. *Leontium rubricorne* n. sp., holotype, × 2.7. FIG. 2. *Clytus oriolinus* (Pascoe), × 4.6. FIG. 3. *Demonax planatus* Pascoe, × 2.7. FIG. 4. *Artimpaza quadricolor* n. sp., holotype, × 3.3. FIG. 5. *Glaucytes quadrifasciata* n. sp., holotype, × 3.3. FIG. 6. *Chlorophorus muscifluvis* n. sp., holotype, × 2.1. FIG. 7. *Leptepania sulcicollis* n. sp., holotype, × 8.7. FIG. 8. *Chloridolum vermiculatum* n. sp., holotype, × 1.8. FIG. 9. *Demonax inscriptus* n. sp., holotype, × 2.3.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hind coxae; legs steel blue with basal third of fore and hind femora and basal two-fifths of middle femora bright red, distal portions of fore and middle femora greenish and tarsi pitchy blackish. Dark areas of pronotum and elytra with short dark pubescence, erect on pronotum and subrecumbent on elytra.

Head deeply grooved medially on frons and vertex, finely and sparsely punctured on lower part of frons, sublongitudinally grooved and slightly punctured on vertex, smooth and nearly impunctate between upper eye-lobes, transversely subrugose-punctate on postocciput, subdensely punctured on genae, vermiculate on postgenae and under side; genae one-half as long as depth of lower eye-lobes. Antennae fully twice as long as body; scape coarsely rugose-punctate, two-thirds as long as third segment; third asperate beneath, shallowly grooved above, subequal to following; last twice as long. Prothorax distinctly longer than breadth at base, slightly narrower at apex than base, with a strong subacuminate tubercle just behind middle of each side and a low swelling at each side between tubercle and apex; disc with central area on each side of median line finely and densely punctured and pubescent, the remainder largely with subregular transverse striolae, oblique on posteriolateral portions of disc and longitudinal, incomplete and interpunctulate along median line; bases of lateral tubercles smooth and anteriorly lateral nodes smooth with a few minute punctures; sternum coarsely and transversely rugose-punctate. Scutellum longer than broad, subacute, smooth with a few transverse or oblique grooves along borders. Elytra distinctly narrowed, each almost obtusely toothed at sutural angle; disc of each minutely punctured on dark portions, less minutely punctured on green stripe. Ventral surfaces minutely punctulate except on black posterior margins of abdominal segments. Legs with fore and middle femora coarsely punctured and hind pair transversely rugose-corrugate and nearly one-third longer than abdomen; hind tibiae straight, flattened and concave medially; first hind tarsal segment slightly longer than next two combined. Length 22.4 mm.: breadth 5.4.

Holotype, male (A.M.N.H.), Palmer River at Black River, Papua, June 15–22, 1936, Archbold Expedition.

Differs from *C. dorycum* (Boisd.) in being more brilliant golden green and less purplish, particularly on borders of pronotum, in having the pale hairs of each elytral stripe shorter, finer, more golden and less transversely recumbent, the elytral apices more angularly produced, the pronotum with two large finely punctured pubescent areas instead of being entirely vermiculate, and in having the middle femora less corrugated.

56. **Chloridolum promissum** Pascoe, 1869

One (A.M.N.H.) Morotai, Moluccas, Mar. 1945, G. Banner.

57. **Chloridolum vermiculatum,** new species

Fig. 8

Female.—Dark green; somewhat golden green with silvery pubescence beneath; pronotal disc somewhat blackish green; outer half of each elytron bluish green to purplish blue; antennae ochraceous with basal

two and one-half segments bronzy green and last two segments and inner half of ninth segment pitchy; legs pitchy brown with a purplish tinge; tarsi and distal portions of tibiae with golden brown hairs.

Head narrowly grooved along middle of vertex and upper portion of frons; clypeus sparsely punctured; frons sparsely punctured and slightly wrinkled; vertex and most of occiput rather deeply and closely punctured; gena irregularly, in part closely, punctured: postgena striolate. Antennae one-third longer than body; scape rugose-punctate, acute ectoapically; third and fifth segments subequal, each longer than fourth; sixth nearly as long as fifth; seventh to tenth shorter; eleventh as long as seventh; sixth to tenth acute ectoapically. Prothorax as long as breadth at lateral tubercles; entire upper surface irregularly vermiculate; apical and basal smooth borders extremely narrow or lacking; lateral tubercle of each side nipple-shaped, on a broad, even base. Scutellum subtriangular, slightly longer than broad, slightly uneven and irregularly punctured. Elytra narrowed posteriorly, each subacute at end of sutural dehiscence, and with disc closely reticulate-punctate on green portion and minutely punctate on dark portion. Ventral surfaces minutely punctulate. Legs slender: hind femur exceeding elytral apex by one-third its length: hind tibia strongly flattened, nearly as wide preapically as femur; first hind tarsal segment slightly longer than remaining segments combined. Length 14 mm.; breadth 3.

Holotype, female (C.A.S.), Hollandia, northern New Guinea, April 1, 1945, S. G. Jewett; ***paratopotype***, same data.

Differs from *C. cinnyris* Pascoe in being slightly larger and less metallic and in having the pronotum entirely covered with vermiculations and without striolations.

58. **Leontium rubricorne,** new species

Fig. 1

Female.—Shiny golden green; elytra darker green with outer two fifths of each blackish blue; antennae brownish red, purplish black on scape, purplish at apices of third to seventh segments and pitchy on distal segments; legs ochraceous to brownish red, pitchy purplish on upper distal parts of fore and middle femora and dark purplish on hind leg except for basal two-fifths of femur. Head and prothorax largely glabrous; elytra with short indistinct suberect dark pubescence; ventral surfaces somewhat frosted and clothed with fine adpressed silvery pubescence.

Head narrowly and deeply grooved along frons and vertex; clypeus finely and sparsely punctured; frons with ridges transverse apically, obliquely transverse on central triangle and obliquely longitudinal above; vertex sublongitudinally ridged in center and punctured on sides of antennal supports; occiput longitudinally ridged anteriorly and subtransversely ridged or punctured behind; gena densely punctured; postgena vermiculate. Antennae one-fourth longer than body; scape rugose-punctate with an indistinct dorsal groove, acute ectoapically; third segment one-half again as long as scape, hardly longer than fourth; fourth to sixth subequal; following shorter; sixth to tenth toothed ectoapically. Prothorax distinctly longer than breadth at

base, about as long as greatest breadth; each side with a broad-based and subacute short tubercle; disc entirely transversely vermiculate, the ridges on posterior two-thirds directed subobliquely forward to middle; apical and basal collars subregularly ridged; base of tubercle ridged; sternum transversely ridged anteriorly and microrugulose behind. Scutellum triangular, slightly concave, finely and sparsely punctured. Elytra slightly narrowed; apex of each oblique with terminal angle subacute, near suture; disc of each finely, densely and subreticulately punctured on inner green portion and more finely so, appearing granulate, on outer dark portion. Ventral surfaces minutely granulose or punctulate. Legs slender; hind femora slightly exceeding elytral apices; hind tibiae straight and flattened; first hind tarsal segment as long as remaining combined. Length 14.8 mm.; breadth 3.25.

Holotype, female (A.M.N.H.), Morotai I., Moluccas, Mar. 1945, Gilbert Banner.

Differs from *Chelidonium pedestre* (Pasc.) in having the fifth antennal segment untoothed apically, the elytra more uniformly punctured on green portion, the prothorax more weakly tuberculate, the antennae largely reddish and the size smaller.

Tribe **Clytini**

59. **Xylotrechus australis** (Castelnau & Gory), 1863

One (C.A.S.) Finschhafen, New Guinea, Oct. 1944, E. S. Ross; several (A.M.N.H.) Fly River, 8 km. below Palmer River and Palmer River at Black River, May-June 1936, Papua, Archbold Exped.; Between Buna and Gona, New Guinea, Mar. 1943, R. Peters; Wide Bay (Queensland ?) No. 3941; (Taiwan Agr. Res. Inst.) Wareng, Geelvink Bay, New Guinea, June 1936, S. Issiki.

60. **Xylotrechus brevicornis** Pascoe, 1869 (?)

One (H.S.P.A.) Mowong, W. Borneo, Sept. 1907, F. Muir.

61. **Xylotrechus pedestris** Pascoe, 1869

One (H.S.P.A.) Mowong, W. Borneo, Sept. 1907, F. Muir.

62. **Clytus oriolinus** (Pascoe), new combination

Fig. 2

Clytanthus oriolinus Pascoe, 1869, Trans. Ent. Soc. London (3) 3: 600 (Salwatty, Mysol).

Head hardly as broad as prothorax, plane in front with median line slightly raised at base of clypeus; antennal supports carinate at margins; occiput finely carinate medially and with a few large punctures at sides. Antennae (last five segments missing) probably reaching to middle of elytra; scape arched, feebly swollen; third segment about as long as scape, a little longer than fourth; fifth shorter than fourth, equal to sixth. Prothorax distinctly longer than broad, nearly as broad as elytra. evenly convex at sides, as broad at apex as at base; disc finely asperate-

granulose. Scutellum subevenly rounded behind. Elytra narrow, feebly attenuated posteriorly; apices truncate, feebly sinuate; discs micropunctulate. Ventral surfaces minutely punctulate. Legs slender; hind femora slightly exceeding elytral apices; first hind tarsal segment slightly longer than remaining combined. Length 7.5 mm.; breadth 1.95.

One female (C.A.S.) Hollandia, northern New Guinea, Sept. 19,1944, Harry Hoogstraal. This species is better placed in *Clytus* than in *Chlorophorus* (*Clytanthus*), though it is from outside the known range of the former. In the original description little was mentioned other than color pattern.

63. **Perissus glaucinus** (Boisduval), 1835

Several (C.A.S.) Hollandia, New Guinea, Oct. 1, 1944, T. Aarons, Febr. 29 and Apr. 16, 1945, S. G. Jewett.

64. **Perissus trizonatus** (Blanchard), 1853 (?)

Three (H.S.P.A.) Amboina, F. Muir.

65. **Chlorophorus aurantiacus** Aurivillius, 1911 (?)

One (H.S.P.A.) Koitaki, 1500 ft., New Guinea, Oct.-Nov. 1926, C. E. Pemberton.

66. **Chlorophorus austerus** (Chevrolat), 1863

Syn., *C. leucothyreus* Pasc.

Some (C.A.S.) Hollandia, New Guinea, Febr.-Mar. 1945, S. G. Jewett; (A.M.N.H.) Palmer River at Black River, Papua, June 1936, Archbold Exped. and Tarara, Papua, Dec. 1936. One (A.M.N.H.) questionably this species: Choiseul I., Solomons, Nov. 22, 1927 (Ac. 27590).

67. **Chlorophorus luxatus** Pascoe, 1869

Several (C.A.S.) Hollandia, N. Guinea, Febr. 10, 1945, S. G. Jewett.

68. **Chlorophorus muscifluvis** Gressitt new species

Fig. 6

Female.—Black to reddish brown, clothed with black, pale green or creamy white pubescence: head blackish with pale green pubescence; antennae dark reddish brown with last five segments thickly clothed above with pale gray-green; prothorax black clothed with pale green except on a large central transversely triangular glabrous area which is irregularly transverse anteriorly and obtuse posteriorly; scutellum pitchy with dense creamy white pubescence; elytra black, clothed with very pale greenish pubescence: narrowly bordering scutellum and along suture for basal third, then dichotomously branching obliquely posteriorward past middle of each disc, the sutural stripe also crossed at end of basal sixth by a transverse band which reaches almost to

humeri, these combined marks forming the Chinese character for "big" surmonted by the scutellum, next a band near end of second third forming a broad isosceles triangle, the apex anteriorward, and finally an apical band forming a more nearly equilateral triangle; ventral surfaces with pale greenish pubescence, becoming much denser and creamy white at sides, but with mesepisternum and bases of second to last abdominal sternites glabrous; legs reddish brown with thin gray-green pubescence.

Head much narrower than prothorax; frons twice as wide below as at top; gena nearly as deep as inferior eye-lobe. Antennae slightly more than one-half as long as body, rather stout; scape slightly longer than third segment; fourth shorter than fifth, which is shorter than third; fifth to ninth segments somewhat tufted endoapically. Prothorax subglobose, a little longer than broad; disc subgranulate to somewhat vermiculate. Scutellum broadly rounded. Elytra hardly broader than prothorax, subevenly narrowed posteriorward, each transversely truncate apically, but with a slight sinuation, the ectoapical angle being somewhat obtusely toothed. Ventral surfaces finely punctured. Legs stout; first hind tarsal segment as long as remaining combined. Length 13.4 mm.; breadth 3.25.

Paratypes.—Pronotum with transverse glabrous band divided into three spots, or lacking.

Holotype, female (H.S.P.A.), Middle Fly River, 250–300 miles from coast, S. New Guinea, July 1928, C. E. Pemberton; ***paratopotype***, female (C.A.S.), same data; ***paratype***, female (H.S.P.A.), Koitaki, New Guinea, alt. 450 meters, Nov.-Dec. 1928, C. E. Pemberton.

Differs from *C. austerus* (Chevr.) in being broader, with stouter antennae, with the elytral markings broader, the post-basal transverse band replacing the parahumeral spot on each elytron.

69. **Chlorophorus praetextus** Pascoe, 1869 (?)

One (H.S.P.A.) Koitaki, alt. 450 meters, New Guinea, Oct.-Nov. 1928, C. E. Pemberton, questionably this species.

70. **Demonax collaris** Pascoe, 1869

Two (H.S.P.A.) Amboina, Moluccas, Mar.-Apr. 1908, F. Muir. Small; black; elytra with three fairly narrow white bands: first nearly at end of basal third, forming an angle at suture, second submedian and transverse.

71. **Demonax inscriptus,** new species

Fig. 9

Pitchy black; in part reddish ochraceous: head pitchy, largely clothed with orange-yellow pubescence; mouthparts largely reddish; antennae black basally, reddish with grayish white pubescence distally; prothorax blackish with sulphur-yellow pubescence except for a pair of sublongitudinal black stripes extending most of length of disc and thickened at ends of each and an elongate-oval black spot with dark brown pubescence at each side; scutellum black with sulphury pubes-

cence; elytra with ground color largely pitchy black, partly ochraceous anteriorly, but densely clothed with orange-yellow pubescence, brighter anteriorly, and marked with following pitchy marks of dark reddish brown pubescence on black background: a narrow longitudinal stripe along each humerus, an obliquely longitudinal stripe from margin below humerus to middle of elytron just external to median line, then turning suddenly anteriorward to just behind scutellum where it curves to suture, joining mate of other elytron to form a sort of "W", or two "V"s with an arcuate connection, thirdly a subtransverse postmedian band greatly broadened at external margins and projecting forward along suture almost to second band as a tapering point, and lastly an obliquely oval spot on each between preceding and apex, touching external margin but not suture; ventral surfaces largely black clothed with thick sulphur-yellow pubescence; legs blackish with sparser yellowish pubescence.

Head distinctly narrower than prothorax; occiput distinctly punctured; genae broad but parallel-sided. Antennae fairly stout, three-fourths as long as body; scape several times as long as broad, slightly arched; third segment about as long as first two segments combined, with a tapering endoapical spine of about one-ninth its length; fourth segment not quite as long as scape, with a strong apical spine of fully one-fourth its length; following subequal in length. Prothorax longer than broad, rounded-oval, rugulose-punctate. Scutellum rounded-triangular. Elytra slightly broader than prothorax; each narrowed and with apex obliquely truncate and strongly spined ectoapically; disc minutely punctulate. Ventral surfaces finely punctured. Legs long; femora fairly stout, reaching well beyond elytral apices; first hind tarsal segment barely longer than following combined. Length 15 mm.; breadth 3.8.

Holotype, male (?) (H.S.P.A.), Borneo, F. Muir.

Differs from *D. mustela* Pasc. in having conspicuous black marks on the prothorax, and in having the elytra very differently marked, the first band W-shaped instead of transverse, and the second more transverse, except for the forward extension along suture.

72. **Demonax planatus** Pascoe, 1869 (?)

Fig. 3

Two (C.A.S.) Maffin Bay, June 20, E. S. Ross and Hollandia, Oct. 1, T. Aarons, northern New Guinea, 1944.

Tribe **Cleomenini**

73. **Artimpaza quadricolor,** new species

Fig. 4

Female.—Red, black and testaceous with areas of silvery pubescence: head red; antennae pitchy black, with first three segments somewhat reddish; prothorax red, slightly pitchy at base; scutellum silvery pubescent; elytra black, each with a median discal stripe of testaceous (nearly colorless) from near base to apical quarter; ventral surfaces black behind fore coxae, with silvery pubescence on parts of coxae,

on mesepisterna, sides of base of metasternum, posterior ends of metepisterna and sides of basal portions of first two abdominal segments. Body surfaces largely smooth and very shiny, largely glabrous except for silvery pubescent areas and sparse long erect hairs which are dark above, paler beneath, sparse on elytra, shorter and more oblique on antennae.

Head slightly narrower than prothorax, heavily but irregularly punctured; frons transverse, with short isolated rows of subconfluent punctures on upper portion; vertex evenly rounded-concave between antennal insertions, medially grooved; occiput sparsely punctured, not grooved behind eyes; genae more closely punctured, about one-third as deep as eyes. Antennae not quite as long as body; sixth to tenth segments distinctly thickened and toothed ectoapically, but hardly compressed; scape not quite as long as third segment, swollen preapically; fourth less than three-fourths as long as third; fifth nearly as long as third; following gradually shorter. Prothorax one-half again as long as broad, evenly rounded at sides, constricted and cylindrical at apex and base; disc with large, not very deep punctures, for most part rather widely separated. Scutellum longer than broad, widest behind middle, rounded apically. Elytra narrowed in basal half; apices narrowed and separately acuminate; disc of each with a number of very irregularly scattered punctures on basal three-fifths and only a sutural row posteriorly. Ventral surfaces sparsely and irregularly punctured, the punctures mostly small; anterior portion of metepisternum largely impunctate; first abdominal segment as long as next two combined. Legs very slender; hind femora reaching elytral apices, suddenly clavate in apical two-fifths; hind tibiae feebly arched; first hind tarsal segment barely longer than next two segments combined. Length 10.5 mm.; breadth 1.9. *Paratype* Length 7.7; breadth 1.6.

Holotype, female (C.A.S.), Hollandia, northern New Guinea, Oct. 1, 1944, T. Aarons; *paratopotypes* (C.A.S. & Lingnan), Nov. 22, 1944, H. Hoogstraal.

Differs from *A. odontoceroides* Th. in having the prothorax almost entirely red, the legs not reddish, the scutellum broadened preapically and the elytra black with an almost colorless instead of a white stripe. In the illustration the hind femora are drawn too stout basally and too straight.

Tribe **Glaucytini**

74. **Glaucytes graphica** (Boisduval) (?)

One (A.M.N.H.) Tulagi, Ysabel, Solomon Is., July 3, 1927 (Ac. 27590).

75. **Glaucytes quadrifasciata,** new species

Fig. 5

Male.—Shiny black with pitchy tinges; antennae reddish with distal segments pitchy; legs reddish with femoral clubs and hind tibiae pitchy. Body extensively clothed with dense golden or silvery pubescence: head entirely clothed with golden above and at sides except along

median line of frons and on a central triangle on occiput; antennae subglabrous; prothorax entirely pubescent except for a small area along middle of disc, goldish above and silvery beneath; scutellum sparsely golden pubescent; elytra with a complete sutural stripe on each, spreading to cover apices, and joining, or nearly touching, four conspicuous transverse bands, also golden, at beginning of each quarter respectively, starting at base, and each in part fully as wide as, or wider than, space separating it from the next, first three broader interiorly, and none quite touching external margin. Ventral surfaces entirely goldish silvery pubescent, except for a glabrous triangle at apex of each of first four abdominal segments; legs thinly clothed with golden buff.

Head slightly narrower than prothorax, with a few large scattered punctures around eyes, particularly between upper lobes; frons constricted, medially grooved and slightly raised apically at middle. Antennae slender, one-fifth longer than body; scape swollen, sparsely punctured, two-thirds as long as third segment; third nearly twice as long as fourth; fifth barely longer than scape; following subequal or slightly shorter. Prothorax about as long as broad, slightly broader at base than at apex, subevenly convex at sides, feebly constricted near apex and base, disc strongly convex, slightly uneven along middle, not distinctly punctured. Scutellum rounded trapeziform. Elytra distinctly and subevenly narrowed posteriorly; apices transversely truncated with outer angles strongly toothed and inner angles briefly toothed; disc of each with many strong punctures in about ten partly regular rows, the punctures continuing almost as large to apices and largely separated by one to two puncture-diameters. Ventral surfaces without obvious puncturation. Legs with femora strongly swollen; hind femora nearly reaching elytral apices; first hind tarsal segment shorter than next two combined. Length 10.2 mm.; breadth 2.65.

Female.—Pubescence sparser on head and prothorax; elytra partly reddish basally; antennae one-sixth shorter than body; hind femora falling considerably short of elytral apices. Length 11.1 mm.; breadth 2.8.

Holotype, male (C.A.S.), Hollandia, northern New Guinea, Dec. 24, 1944, Harry Hoogstraal; ***allotopotype***, female (C.A.S.), Apr. 16, 1945, S. G. Jewett; ***paratopotype*** (Chicago Nat. Hist. Mus.), Hoogstraal.

Differs from *G. graphica* (Boisd.) in having the prothorax almost entirely pubescent instead of striped, and with four broad bands and apical spot of golden on each elytron, the prothorax without a transverse ridge, the antennae much more slender and with the third segment relatively longer, and with the elytral apices more transversely truncate. In the illustration, the prothorax should be subtransverse, instead of emarginate basally, and the femora should be more slender basally.

KEY TO THE SPECIES OF GLAUCYTES FROM THE SOUTH PACIFIC

1. Body black or reddish brown, sometimes slightly metallic. 2
   Body metallic green; prothorax with a yellow stripe on each side of disc; elytra each with two disconnected longitudinal yellow stripes; New Hebrides. . . . . **helenae** White
2. Pronotum with two longitudinal pubescent stripes or almost entirely pubescent. 3
   Pronotum with four longitudinal golden or silvery stripes. 5

3. Pronotum in large part evenly pubescent, not striped..... 4
   Pronotum with two longitudinal silky white stripes; each elytron with a basal longitudinal stripe, three discal spots and posterior part of suture pubescent; Santa Cruz I..... **sanctaecrucis** Heller
4. Each elytron with four broad obliquely transverse bands (besides apical spot), and entire suture, clothed with golden pubescence; each elytral apex with only outer angle strongly toothed; N. New Guinea, **quadrifasciata** Gress.
   Each elytron with four spots, including apical spot, of silvery white pubescence; each elytral apex with both angles distinctly toothed; Batchian (Moluccas)..... **scitula** Pasc.
5. Body black; each elytral apex with two teeth..... 6
   Body reddish brown; each elytral apex with two sharp spines; pubescence golden; each elytron with a discal stripe reaching nearly to middle; Fiji Is..... **muiri** Gress.
6. Each elytral disc with three large spots, besides some pubescence near scutellum, of golden; Samoa Is..... **aureosignata** Aur.
   Each elytral disc with a median stripe to just beyond end of basal third, followed by two spots, as well as a short lateral stripe behind humerus, of silvery golden; Solomon Is..... **graphica** (Boisd.)

DUSENIA, PUBLICATIO PERIODICA DE SCIENTIA NATURALI. Av. Vicente Machado, 1446, Curitiba, Paraná, Brazil.

This new periodical, which began publication in January, 1950, is named in honor of the Swedish-born botanist, Per Karl Hjalmar Dusen, who later lived in Brazil and who contributed much to the knowledge of the flora of southern South America. The present editor is Ralph J. G. Hertel. According to the editorial statement, articles may deal with the natural sciences, including "botany, zoology, biology, geology, petrography, mineralogy, paleontology, biogeography, physical geography, biochemistry, biophysics, and anthropology including linguistics (preferably indigenous)" (translation). Volume I consists of six issues which appeared bimonthly, starting in January, and which totaled 396 pages. We have received the first issue of Volume II, dated January, 1951.

Dusenia presents a very good appearance. The articles seem to be substantial and are devoted to original research. The editing is good and the illustrations, including halftones as well as line drawings, are well reproduced, except insofar as an occasional halftone appears to be made from a defective print. There is some variation in the quality of the paper, but this probably represents an attempt on the part of the editor to standardize on a satisfactory but economical grade. The later issues use a cheaper but satisfactory paper, with a much better grade for use in plates.

The subject matter of Volume I is very strongly entomological, 295 pages being devoted to articles in that field. This should be a strong recommendation to all entomologists interested in the Neotropical fauna. Arranged according to taxonomic groups, there are articles on the Diptera by Messias Carrera (Asilidae, Bombyliidae), John Lane (Mycetrophilidae), Renato R. Corrêa, Firmino O. Lima and Alberto S. Ramos (Culicidae), C. Pavan and Juan Nacrur (Drosophilidae), and Maria d'Andretta (Bombyliidae); on the Hymenoptera by Pe. J. S. Moure, Warwick E. Kerr, and Wolfgang Krause (Apoidea); on the Coleoptera by Frederico Lane (Cerambycoidea), Karl Schedl (Scolytoidea), and Angelo da Costa Lima (Curculionidae); and on the Hemiptera by Oswaldo P. Forattini and Oswaldo S. Serra (Reduviidae). In the related field, Otto Schubart has a twenty-page paper on the Diplopoda. The predominance of entomological articles continues into number 1 of Volume II.

The editor is to be congratulated on this venture into the publication field in the natural sciences, and we hope that his periodical will be successful enough to warrant its continuation.—M. T. J.

NEW AND DESCRIBED PARASITES OF THE GENUS EURYTOMA ILLIGER FROM ROSE GALLS CAUSED BY SPECIES OF THE CYNIPID GENUS DIPLOLEPIS GEOFFREY

(Hymenoptera: Eurytomidae)

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The material utilized in this study came from the collections of the United States National Museum, the Illinois Natural History Survey, S. E. Lienk, A. C. Kinsey and my own. The specimens from the United States National Museum were collected by many individuals whose names are given in the list of locality records under each species and subspecies, described below.

The study has resulted in the description of ten new species of parasitic eurytomids bred from rose galls, and a redescription of two previously described species. All occur in either the United States, Canada or both. It will be obvious that in most of the cases more material from a greater number of localities is needed to delimit ranges and differentiate subspecies properly. Nevertheless, subspecific populations have been described for some of the species and indications of others suggested in the remarks that follow the descriptions. Range and host relationships are also discussed but because of inadequate material and lack of life-history data definite conclusions cannot always be stated. With these limits in mind some general considerations are presented before the systematic part of the paper.

DIPLOLEPIS GEOFFREY 1762 VERSUS RHODITES HARTIG 1840

There is considerable confusion in the literature as to just which generic name should be applied to the cynipid gall-makers on rose. Kloet and Hincks (1945) seem to favor *Rhodites* Hartig even though they indicate that more research is needed to establish *Rhodites*. The name is cited first in their list and, I presume, represents their considered judgement. On the other hand Kinsey, beginning with his 1922 paper, uses *Diplolepis*. He has based his usage on the work of Rohwer and Fagan (1917) who go to some pains to explain why they believe *Diplolepis* is a valid term. Since Kinsey has considered their reasons adequate it seems best to follow Rohwer and Fagan and accept *Diplolepis* rather than *Rhodites*.

PREVIOUSLY DESCRIBED SPECIES

Only one species of eurytomid from North America has been previously described from rose galls. Fullaway described *Eurytoma incerta*

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in 1912 from California without a specific host designation but indicated that it emerged from an unidentified rose gall. The anomalous status of this species today is discussed in the systematic portion of the paper. *E. obtusilobae*, described by Ashmead in 1885, was bred from an undetermined cynipid gall. No further mention of this species has occurred in the literature until the present paper in which it is recorded from the rose gall *Diplolepis radicum*.

HOST RELATIONSHIPS

The species of eurytomids treated in the following pages are bred from galls on rose produced by species of the cynipid genus *Diplolepis* Geoffrey (= *Rhodites* Hartig). Felt (1940) lists some 27 species of rose galls as well as many varieties. In general, the different parasitic species are restricted to a single species of host gall-maker or to two or more varieties of a single species. In a few instances, a parasite has been bred from galls of more than one host species, *viz.*, *Eurytoma spongiosa* from galls of *Diplolepis rosae*, *D. dichlocerus* and *D. tuberculatrix; Eurytoma incerta* from *D. tuberculatrix* (= *D. neglecta*) and *D. politus*. The interpretation of *neglecta* galls as merely modified inquiline inhabited galls of *D. tuberculatrix* (Kinsey and Ayres, 1922) presents a situation that is suspected of being true of other species (*D. globuloides*, and *D. bicolor*) but cannot be stated as certain until more detailed investigations have been made. The interesting relationship cited above is discussed in more detail under the description of *Eurytoma discordans* and *E. acuta* further on.

In displaying some degree of host restriction, eurytomid rose gall parasites fall in line with studies made of species from Mexico bred from cynipid oak galls (Bugbee 1941 a and b, 1944 a and b, 1945) and other genera of the family Eurytomidae (*Harmolita*, Phillips and Emery, 1919; Phillips, 1936; *Rileya*, Gahan, 1918.) This adds support to the generalization that, in most cases, eurytomid species are restricted to either a single host species or to two or more closely related host species. The case of *E. obtusilobae* may be an exception to the generalization. Note the discussion under the redescription of this species.

The exact host of the parasite within the gall is not easily determined. Just because a parasite issues from a gall is not conclusive evidence that it is parasitic upon the gall-maker. As a matter of fact the too few studies that have been made of the relationships that may exist within galls (Triggerson, 1914; Phillips, 1927; Noble, 1939; Blair, 1945) have shown that several species of parasites usually occur, often representing different families or even orders, and that all classes of parasitism may be evidenced. Thus there may be one or more primary parasitic species of the gall-maker as well as species of secondary parasites and hyperparasites of the parasites, etc. Therefore it should be clearly understood that where hosts are given in this paper, all that is indicated is that the parasites were *bred* or *emerged* from that particular host gall. This is especially true where more than one species of eurytomid was secured from galls of a single species of host, *e.g.*, *E. acuta*, *E. incerta*, and *E. spongiosa* from *Diplolepis tuberculatrix* galls. Only life-history studies of these species can determine their specific parasitic relationships within the galls.

BIOLOGY

Very little is known about the general biology of any of the parasitic species from rose galls. No complete life-histories have ever been worked out for any of the Neartic species. Blair (1945) has given a detailed account of the biology of ***Eurytoma rosae*** Nees, an Old World species bred from galls of ***Diplolepis*** (= ***Rhodites***) ***rosae***, where it acts as an external parasite of the inquiline ***Periclistus brandtii***.

Some data can be added here concerning emergence dates and male and female ratios of Neartic species. For most of them the height of emergence comes in May or June with smaller numbers appearing in April and July. The parasites begin their emergence after the height of the emergence of the gall-makers so that the first few parasites usually overlap the later emerging gall-makers. Males of the eurytomids appear in greater numbers first with only a sprinkling of females, and later the ratio is reversed.

The larger series present sex ratios that are approximately equal although females are usually more numerous. The series representing *E. calcarea*, for instance, showed 227 males to 275 females or 45% males to 55% females. If accurate daily records had been kept on all series the ratio would have been more nearly a 50 to 50 ratio. In one long series of *E. calcarea* where fairly complete records are available there are 151 males to 150 females. In some of the small series for such species as *E. flavicrurensa* and *E. spina*, no males occur. This may be due to poor sampling and if larger series were at hand males would probably be represented.

PHYLOGENY

The interpretation of relationships, before an overall study of the whole genus ***Eurytoma***, would be hazardous and presumptive. Only certain general suggestions as to phylogenetic affinities can be mentioned now. In a series of papers by the author, referred to previously (page 214), 33 new species of Mexican eurytomid parasites from cynipid oak galls were described and arranged in six major groups, *viz.*, ***mucronura***, ***atrateges***, ***breviura***, ***aureata***, ***quadrata*** and ***corpulenta*** groups. The question naturally arises whether the Neartic material from rose galls falls into one or more of these groups or represents entirely unrelated groups. The latter appears to be the case, as might be expected, since the host cynipids (***Diplolepis*** species) and host plants (***Rosa*** species) are not close relatives of oak cynipids or oak trees (***Quercus*** species). Closer relationships will probably be found between Mexican, United States, and Canadian oak-gall eurytomid parasites when studies of the latter material are made.

The rose-gall parasites seem to fall into four groups. The ***discordans*** group contains four closely related species, *E. discordans*, the *E. acuta* complex of five subspecies, the *E. incerta* complex of two subspecies, and *E. terrea*. The hosts of the first two species (***Diplolepis globuloides***, ***D. tuberculatrix***, and ***D. neglecta***), are clearly closely related. The affinities of the fourth host, ***D. politus***, are not as clear. The fact that one of its eurytomid parasites can be placed in the *E. incerta* complex (page 236) and a second species, (*E. terrea*) is close to *E. incerta* suggests a close relationship to the other host species that may be confirmed by

future life-history studies of *D. politus*. This host gall might also be a modified inquiline inhabited gall as in the case of *D. globuloides* and *D. neglecta*, or simply a close relative of *D. tuberculatrix*. The latter seems the most plausible.

Another point of interest is that most of the evidence (discussed under host relations for each parasitic species) points to the suspicion that the parasites of the *discordans* group attack inquilines or some other inhabitant of the gall instead of the true gall-maker. It would not be surprising therefore to find that the material from *D. politus* galls do likewise. Confirmation of this must await further study also.

E. discordans is an eastern species and does not range west of the Mississippi River. *E. acuta* is primarily mid-western although it reaches eastward into Michigan through the northern states and southern Canada. Its westward boundry seems to be the Sierra Nevada range of mountains in eastern California. *E. incerta* (Map I) occurs along the west coast in California and Oregon and *E. terrea* is known, so far, only from one locality in the latter state. The *discordans* group is most closely related to the following and grades into it as pointed out under the description of *E. calcarea*.

The second or *calcarea* group contains three species, the *E. calcarea* complex of six subspecies, *E. longavena*, and *E. spina*. This is a much more variable group of species than the previous one. The inclusion of *E. spina* is questionable since it is based on a very small series (five females). Its host, *D. tuberculatrix* var., is quite different from the other species hosts also, but in spite of these objections it seems to be closer to the *calcarea* group than to any of the others.

E. calcarea and *E. longavena* have more in common as their hosts are related. The former issues from galls of *D. variabilis*, *D. bicolor*, and *D. nebulosus* and the latter is recorded from *D. bicolor* only. *E. calcarea* occurs in the eastern two-thirds of the United States (Map II) and *E. longavena* far to the north in Canada (Terrace, British Columbia, Map V).

Kinsey and Ayres (1922) state that *D. bicolor* also shows modified inquiline inhabited galls but as yet there is no dependable clue as to just what the eurtyomid parasites of this group attack in the galls. The fact that the *calcarea* group shows relationships with the *discordans* group, that does have strong evidence to support the latters parasitizing of inquiline or other parasitic species within the galls, is only a weak suggestion as to the formers possible host.

A close relationship of the host species *D. variabilis* and *D. bicolor*, is suggested, in that *E. calcarea* is bred from both galls, although no substantiation of the close relationship of the two hosts is mentioned in any literature dealing with rose galls and their cynipid makers examined to date.

Like the preceding material the third or *spongiosa* group, contains four species that present a wide range of variation. Included are *Eurytoma spongiosa* and its variant *E. s. curvavena* from *D. rosae*, *D. dichlocerus* and *D. tuberculatrix* varieties, *E. imminuta* from *D. variabilis* galls, *E. flavicrurensa* from *D. politus* and *E. iniquus* from *D. neglecta* galls. The *calcarea* and *spongiosa* groups grade into each

other but in general the latter group of species has female genitalia with broad, stout dorsal valves, shorter more stubby ninth abdominal segment (end of dorsal valves) and the reduced extension dorsally, of the anterior parts of the dorsal and ventral valves which causes the stylet arch to approximate a horizontal plane (figs. 15, 18, and 23).

E. spongiosa is probably a complex of subspecies but in most cases the series from the different localities are small and therefore not sufficient to give a clear picture of the variational limits. The range of this species covers most if not all of the United States, east of the Sierra Nevada range of California (Map III). At least one of its host galls occurs over the same general area also (*D. rosae;* Kinsey, 1922).

E. spongiosa curvavena is a subspecies that resembles most closely *E. spongiosa.* Its range is confined to northern Minnesota. Its host galls are formed by a variety of *Diplolepis tuberculatrix* (probably *D. t. multispinosa*).

Its most curious feature is the unusual bent postmarginal vein that is discussed in more detail under the description of *E. curvavena.*

E. imminuta is close to the preceding species in general structural characteristics but its host is quite different. In its extremely short ninth abdominal segment and weak development of the female genitalia (fig. 24) the species stands out from all the other eurytomid species from rose. It is confined to the Great Basin region of Nevada and Utah (Map V).

E. flavicurensa seems to fit in the *spongiosa* group better than anywhere else but more material of this species is needed to be sure of its range and exact affinities (Map V).

E. iniquus from *D. neglecta* galls resembles *E. spongiosa* in some of its features and *E. flavicurensa* in others. It occurs on the eastern slope of the Rockies in central Colorado.

In the fourth group is placed *E. obtusilobae* Ashmead. It is bred from galls of *Diplolepis radicum* (Osten Sacken), a root gall on various species of rose. In many of its characteristics, as noted further on, it resembles several eurytomid species bred from oak galls (*E. californica, E. seminatrix*) more closely than any of the previously mentioned rose species of *Eurytoma.* The species has a wide range. Locality records from along the east coast and the states of Oregon and Utah, occur in the material studied (Map IV) and Kinsey (1922) states that its host probably occurs "everywhere in North America where roses occur."

Although Kinsey (1922) describes a number of varieties of the host cynipid (*D. radicum*) there is too little of the eurytomid material to determine subspecies clearly. The western material does average larger in most of its measurements than the eastern specimens but access to longer series from many more localities is needed before a further breakdown can be made.

In summary it may be said that the first three groups, *viz., discordans, calcarea,* and *spongiosa* groups are related in the order named. Each group grades into the other, suggesting a common ancestral background. The most primitive or least specialized members of this evolutionary line occur among the *spongiosa* group, This is reflected, among other things, in multiple host species, weakly developed female genitalia,

extensive ranges, plump abdomens (lack of lateral compression) and narrow sixth abdominal segment. The *discordans* group seems to show the highest degree of specialization structurally as well as a greater degree of host restriction. *E. obtusilobae* on the other hand, the only member of the fourth group, seems to be quite apart and therefore represents a different line of evolution, only distantly related, if at all, to the other three groups. Just where its closest affinities will occur must await further study of the oak gall parasites of the genus *Eurytoma*.

SYSTEMATIC DESCRIPTIONS

The groups outlined in the previous section, are not described or assigned any particular status. This conforms with the same treatment accorded the six groups referred to previously, into which the Mexican eurytomid species were divided. The term *complex* is used here to refer to a species and its subspecies populations, *e.g. E. acuta* complex. Where subspecies within a species seem to fall into two or more divisions the term subcomplex is used, *e.g.*, the *acuta* and *absona* subcomplexes of the *E. acuta* complex. Where more than one host is involved, the first one listed under that heading, following the descriptions, refers to the host of the "types." Additional host citations refer to paratype series detailed under the caption, "paratypes, not topotypical."

KEY TO THE SPECIES OF EURYTOMA FROM ROSE GALLS

(Based on females only)

A. Large, averaging 4 to 5 mm. in length (range 3.5–6.6 mm.); abdomen averaging 2 mm. or better in length (range 1.8–3.8 mm.); internal genitalia averages 2 mm. or better in length.
  B. Abdomen laterally compressed and dorsally produced; ninth abdominal segment long and sharply pointed, averaging 0.40 mm. or better in length; internal genitalia strongly developed dorsally, averaging 1.4–1.7 mm. in height.
    C. Scape, fore and mid-legs most often all yellowish-brown; black on femurs and tibiae of hind-legs; wing veins pale clay-yellow; marginal vein thin or linear; stigmal club very narrow to linear ..... **1. discordans**
    CC. Scape, femurs and tibiae of all legs most often with some black infuscation; wing veins yellowish-brown; marginal vein narrow to broad but never linear; stigmal club rectangular to square. . **2. acuta**
  BB. Abdomen plump or with only slight lateral compression; ninth abdominal segment elongate averaging 0.21 mm. to 0.30 mm. in length; sculpturing on surface of sixth abdominal segment heavy and extending upward and across dorsal surface of segment.
    C. Ninth abdominal segment averages 0.21 mm. in length; anterior end of internal genitalia flat or only slightly extended dorsally; averages in height 0.95 mm.; anterior plate of ventral valves narrow, averaging 0.17 mm. in width ..... **3. terrea**
    CC. Ninth abdominal segment averages 0.28 mm. in length; anterior end of internal genitalia produced dorsally, averaging 1.2 mm. in height; anterior plate of ventral valves broad, averaging 0.27 mm. in width ..... **4. incerta**
AA. Small, averaging from 3–4 mm. in length; abdomen plump, not greatly produced dorsally, anteriorly, averaging 2 mm. or less in length; ninth short and stubby, averaging from 0.10 to 0.23 mm. in length; internal genitalia averaging less than 2 mm. in length and 1 mm. or less in height.

B. Ninth abdominal segment short and broad, averaging 0.18–0.23 mm. in length; internal genitalia only slightly developed dorsally; dorsal valves thin and of uniform width for horizontal length and they turn dorsally anteriorly at slightly less than a right angle; overall length of genitalia averages 1.6–1.9 mm. and height 1.0 mm.
  C. Ninth abdominal segment averages 0.18–0.19 mm. in length; marginal vein considerably longer than postmarginal by at least 0.05 mm. difference; flagellum of antennae clearly 7-segmented.
    D. Ninth abdominal segment averages 0.18 mm. in length; scape dark brown to black or yellow at extreme base only; marginal vein considerably longer than postmarginal; marginal averages 0.42 mm. and postmarginal 0.29 mm.; segments of flagellum moniliform ..... **5. longavena**
    DD. Ninth abdominal segment averages 0.19 mm. in length; scape fore- and mid-coxae, femurs and tibiae of all legs yellow; marginal vein averages 0.37 mm. and postmarginal 0.30 mm. in length ..... **6. flavicrurensa**
  CC. Ninth abdominal segment averages 0.22–0.23 mm. in length; marginal vein only slightly longer than postmarginal; marginal averages 0.35 mm. while postmarginal averages 0.30 mm. in length; flagellum of antennae 6- or 7-segmented.
    D. Ninth abdominal segment averages 0.23 mm. in length; propodeum most often with a wide, shallow median furrow; flagellum of antennae 7-segmented and segments longer than wide; never moniliform; internal genitalia mediumly developed; dorsal valves thin and same width throughout horizontal length ..... **7. calcarea**
    DD. Ninth abdominal segment averages 0.22 mm. in length; propodeum with a narrow, shallow median furrow; antennae with the flagellum 6-segmented; seventh segment composed of three closely fused segments; internal genitalia weakly developed dorsally; dorsal valves broad for horizontal length ..... **8. spina**

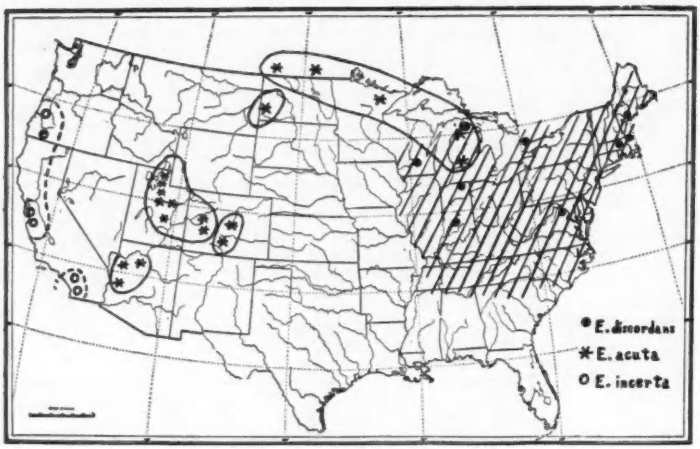
BB. Ninth bdominal segment extremely short and stubby, averaging less than 0.18 mm. in length (range 0.10–0.15 mm.).
  C. Scape, fore and mid-legs brown to golden yellow.
    D. Tegulae, pedicle and often flagellum yellow or light brown; marginal vein narrowly rectangular; wing veins yellow; ninth abdominal segment short, averaging 0.13 mm. in length; internal genitalia flat dorsally ..... **9. obtusilobae**
    DD. Tegulae black to dark brown; flagellum black; marginal vein broad; wing veins brown; ninth abdominal segment averages 0.15 mm. in length; internal genitalia developed dorsally, anteriorly ..... **10. iniquus**
  CC. Tegulae black; legs usually with some black infuscation on all femurs and tibiae; a few with fore and mid-legs all yellow; scape usually all yellow or upper tip black only; ninth abdominal segment varies from an average of 0.10 to 0.15 mm. in length.
    D. Ninth abdominal segment extremely short, averaging only 0.10 mm. in length; sixth abdominal segment narrow, averaging 0.38 mm. at widest point; internal genitalia weakly developed, averaging 1.3 mm. in length and 0.7 mm. in height ..... **11. imminuta**
    DD. Ninth abdominal segment averages about 0.15 mm. in length; sixth abdominal segment of medium width, averaging 0.45–.50 mm. in width; internal genitalia weakly developed, averaging 1.4–1.6 mm. in length and 0.86–1.0 mm. in height ..... **12. spongiosa**

DISCORDANS GROUP

Eurytoma discordans n. sp.

Figs. 1, 2 and 3; Map I

Female.—Black. Length 4.0–5.5 mm. (aver. 4.8). Abdomen oval from the side; laterally compressed; width 0.65–1.0 mm. (aver. 0.85); depth 1.0–1.4 mm. (aver. 1.2); thus the depth is 1.45 times the width; length of the abdomen 2.2–3.3 mm. (aver. 2.7); silvery-white pile on the dorso-lateral aspect of segment 6 range from 2 to 7 (aver. 4.1); segments 7 and 8 well covered with silvery pile; exposed tips of dorsal valves elongate and pointed; length 0.27–0.60 mm. (aver. 0.43), or



MAP I

Distribution of Eurytoma discordans, E. acuta and E. incerta.

abdomen is 6.2 times the length of dorsal valves; length of sixth abdominal segment aver. 0.67 mm. (range 0.55–0.80 mm.); thus it equals about 25% of length of abdomen. Average length of internal genitalia 2.7 mm. (range 2.6–3.1) and height 1.7 mm. (range 1.5–2.0); anterior dorsal bending of dorsal and ventral valves less than a right angle; ventral valves do not turn back on themselves; anterior brownish plate of ventral valves averaging 0.37 mm. at widest point (range 0.35–0.40 mm.); stylet arch in an oblique plane; dorsal valves maintain same narrow width for horizontal length and black color fades out just before or after they turn dorsally; angle formed by horizontal and tangent lines averaging 35° (range 31°–37°). Thorax with tegulae black. Propodeum with a wide median furrow that maintains same width or narrows slightly, ventrally, in some specimens; ridges across furrow regular, dividing surface into rectangles with largest and most

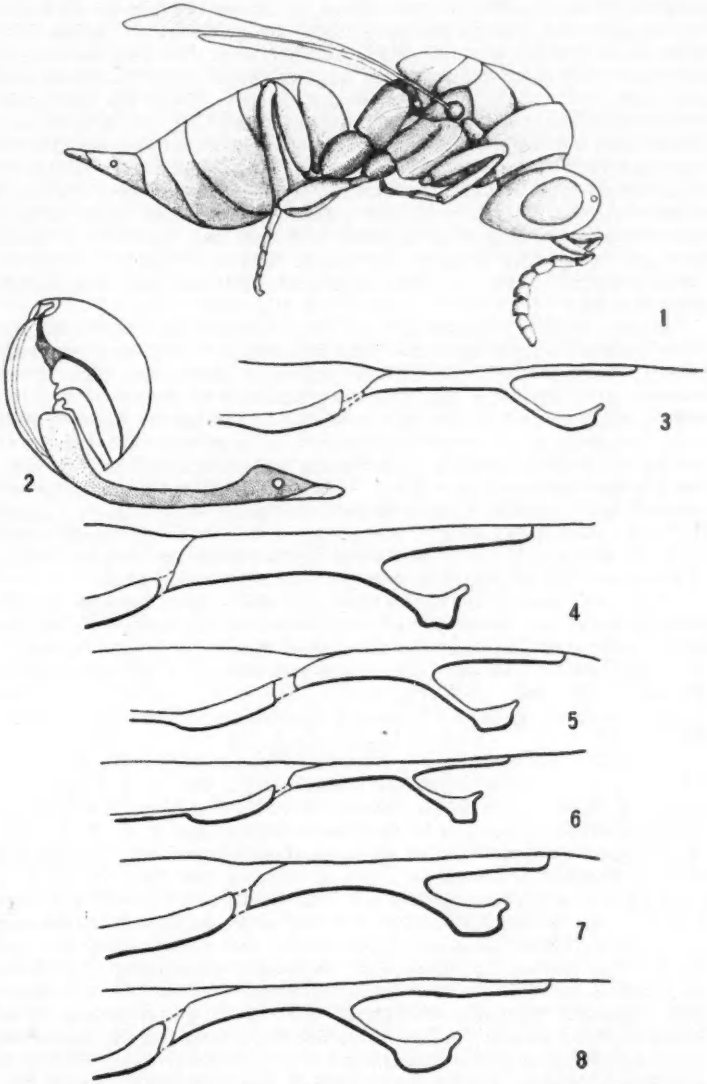


FIG. 1. *Eurytoma discordans*, female. 18×. FIG. 2. *E. discordans*, female genitalia. 18×. FIG. 3. *E. discordans*, outline of marginal, postmarginal and stigmal veins. 50×. FIG. 4. *E. acuta acuta*, same as above. FIG. 5. *E. acuta intermedia*, same as above. FIG. 6. *E. a. ramosa*, same as above. FIG. 7. *E. a. absona*, same as above. FIG. 8. *E. a. gemina*, same as above.

irregular at top; deep pit below base of furrow appears divided into two shallow foveae in some specimens; areas lateral to furrow with large 5- to 6-sided pits dorsally; ventrally only fine irregular ridges. Antennae with outer face of scape most often all yellowish-brown; few specimens with slight black tinge at top only. Fore-legs yellowish-brown; mid-legs yellowish-brown or slight black tinge on outer face of tibiae only; hind-legs with femurs and tibiae black except tips which are yellowish-brown; rarely slight black smudge on fore and mid-femurs. Wing veins pale clay-yellow to light-brown; stigmal vein long and narrow; stigmal club narrowly rectangular, never square; marginal vein narrow to linear; length varies from 0.32–0.50 mm. (aver. 0.41); postmarginal vein varies in length from 0.27–0.47 mm. (aver. 0.37); most often marginal aver. 1.1 times length of postmarginal; occasionally both are equal.

Males.—Black. Length 2.1–3.7 mm. (aver. 3.0). Outer face of scape yellow or upper half black and rest yellow. Fore-legs yellowish-brown; mid-legs with the femurs yellowish-brown and slight black smudge on outer face of mid-tibiae from middle to outer tip; hind-legs with a black or dark-brown spot medially on the femurs which may or may not cover whole outer face; fades into brown or yellowish-brown ventrally; hind-tibiae with black infuscation covering all or only lower two-thirds, except tips. Wing veins pale-yellow to light-brown; stigmal club narrowly rectangular; marginal vein narrow, length 0.27–0.45 mm. (aver. 0.35); postmarginal 0.27–0.37 mm. long (aver. 0.32); in about half of the specimens the two veins are equal in length, in the other half the marginal is longer than the postmarginal.

Types.—Topotypical, 9 females and 12 males; ***holotype*** female, ***allotype*** male, and ***paratypes*** of both sexes in the Bugbee Collection. ***Paratopotypes*** of both sexes in the United States National Museum.

Type locality.—Howe, Indiana, six miles west. Galls collected on December 20, 1930. J. Murray coll.

Host.—From galls of ***Diplolepis globuloides*** on species of ***Rosa***, Kinsey det.

Paratypes, not topotypical. INDIANA: Bloomington, collected March 22, 1921, from galls of ***Diplolepis globuloides*** on ***Rosa***, 2 females and 2 males; 1 female from Bloomington, 10 miles southeast, collected on March 2, 1935, removed (dead) from breeding cage on July 11, 1935, from galls of ***D. globuloides*** on ***Rosa***, Bugbee coll. and det. MASSACHUSETTES: Nahant, collected on April 6, 1910, issued May 20–25, 1910 from galls of ***Diplolepis globuloides***, Timberlake coll., no. 96, 5 females and 2 males; Forest Hills, May 11, 1919, from galls of ***D. globuloides***, Kinsey det., 13 females and 8 males. VIRGINIA: Vienna, May 23, 1911, R. A. Cushman coll., parasite of ***Diplolepis globuloides***, Quaintance no. 7049, 4 females. MICHIGAN: Cheboygan, collected on October 3, 1927, emerged May 15, 1928 from galls of ***D. globuloides*** on ***Rosa***, Kinsey coll. and det., 4 males. WISCONSIN: Kilbourn City, June 1907, from gall of ***Diplolepis globuloides***, from collection of L. H. Weld, 1 female. MAINE: Brunswick, collected April 16, 1907, issued May 10–20, 1908, from galls of ***Diplolepis globuloides***, Timberlake coll., no. 96, 1 female. CANADA: Toronto, collected by D. C. Cox, from galls on ***Rosa blauda***, 2 females and 4 males.

Range.—*Eurytoma discordans* is an unusually uniform species ranging over the eastern United States (Map I). Its westward boundary appears to be the Mississippi River valley. As more material accumulates the range of the species will probably be extended further into Canada and southward towards the gulf coast states.

Host relationships.—The exact host relationships of *E. discordans* present an anomalous picture. The supposed host species, *Diplolepis globuloides* (Beutenmuller), has been known since 1892 from the gall only (Beutenmuller, 1892). According to Kinsey and Ayres (1922:162) *globuloides* is a cynipid gall that is modified by an inquiline, probably *Periclistis pirata* O. S. This is suggested by the fact that although Kinsey has collected hundreds of *globuloides* galls he has bred only inquilines from them and "not a single gall maker." It is his belief that the true gall maker has never been described and that he has "no data as yet to show what species of rose gall becomes *globuloides* when inhabited by inquilines." A similar situation was found in the case of *Diplolepis neglecta* (Gillette) which turned out to be "only inquiline-inhabited galls of *D. tuberculatrix*" (Kinsey and Ayers, 1922:161) and not a distinct species of *Diplolepis*. It is obvious therefore that *E. discordans* could not be a parasite of the unknown true gall-maker but more likely is a parasite of the inquiline *Periclistis pirata*, or acts as a primary or secondary parasite on one or more species of other chalcids, representing several families, that may be bred from *globuloides* galls.

Remarks.—*E. discordans* differs from *E. acuta* n. sp. and its subspecies, in color of the scape (all yellow or upper extremity black only); color of the wing veins (pale clay-yellow); narrowness of the stigmal club and marginal vein (fig. 3.); presence of a wide median furrow on the propodeum which is usually not differentiated from the lateral areas by distinct carineae and which maintains the same width throughout its length. Its range and host are also distinguishing features.

Eurytoma acuta n. sp.

Figs. **4, 5, 6, 7,** 8; Map I

Female.—Black. Length 3.7–6.6 mm. (aver. 5.1). Abdomen oval from a side view and laterally compressed; dorsal and ventral valves project slightly above the horizontal axis of the abdomen; length of the abdomen, 2.0–3.8 mm. (aver. 3.0); width of sixth abdominal segment, at its widest point, 0.55–0.95 mm. (aver. 0.75); thus it averages about 25% of the length of the abdomen; exposed dorsal valves long and pointed, length 0.28–0.63 mm. (aver. 0.49). Internal genitalia 2.1–3.2 mm. long (aver. 2.6); height 1.2–2.1 mm. (aver. 1.7); dorsal and ventral valves turn dorsally, anteriorly, at less than a right angle and ventral valves expand into a broad brownish colored plate that averages 0.36 mm. at its widest point (range 0.25–0.42 mm.); dorsal valves black and maintain same narrow width for entire length; stylet arch less than a vertical plane; angle formed by tangent and horizontal lines averages 37° (range 34°–42°). Thorax with tegulae black. Propodeum with a wide median furrow that narrows gradually ventrally; ridges across furrow irregular, forming triangles and rectangles; largest towards top,

becoming small and indefinite ventrally; at base of furrow is an indented area that may be divided into three deep foveae in many specimens; areas lateral to furrow marked by distinct carinated 5- to 6-sided pits dorsally, which become indistinct ventrally. Antennae with face of scape most often with upper-half black and lower-half yellow to yellowish-brown or all yellowish-brown except black upper tip. Legs most often with varying amounts of black infuscation on all femurs and tibiae; less often femurs and tibiae of fore and mid-legs all yellow to yellowish-brown. Wing veins light yellowish-brown to dark brown; marginal vein may be narrow, but most often is broad; averages in length 0.42 mm. (range 0.32–0.55); postmarginal vein averages in length 0.39 mm. (range 0.27–0.52); in different populations the postmarginal may be shorter than, equal to, or longer than the marginal; stigmal club is never narrowly rectangular but always deeply rectangular to square in outline.

Male.—Black. Length 3.0–4.2 mm. (aver. 3.6). Scape may be all black or dark-brown except yellowish-brown base, or upper-half black and lower-half yellowish-brown. Most often fore and mid-legs all yellowish-brown and hind-legs with black infuscation covering all but tips of femurs and tibiae, or varying amounts of black infuscation on all femurs and tibiae; in the latter case the amount of black increases from front to hind-legs. Wing veins light yellowish-brown to dark-brown; marginal vein broad and stout, averaging in length 0.40 mm. (range 0.35–0.47); postmarginal vein averages 0.37 mm. (range 0.32–0.42); length of postmarginal and marginal and shape of the stigmal club as in the female.

Types.—Detailed under the various subspecies.

Range.—From central and northern Michigan, north-westward through Minnesota and North Dakota into southern Canada (Manitoba and Saskatchewan); southward through Colorado and Arizona and westward through Utah, probably to the eastern slopes of the Sierra Nevada (Map I). *E. acuta* is replaced east of the Mississippi, except as noted above, by *E. discordans*. Along the west coast occurs still a third closely related species (*E. incerta*) described further on.

Host relationships. Bred from galls of the *Diplolepis tuberculatrix* (Cockerell) complex (Kinsey and Ayres, 1922). The more precise host relationships are given and discussed below with the descriptions of the subspecies of *E. acuta*. The host galls occur on various species of the genus *Rosa*.

Remarks.—The chief differences between *E. acuta* and its closest relative, *E. discordans*, are explained in connection with the description of the latter.

Five subspecies are described under *E. acuta*. The subspecies are separated into two subgroups or subcomplexes. The *acuta* subcomplex includes the first three closely related subspecies that follow and which have a more northerly range than the second subcomplex. The second, *absona* subcomplex, includes the last two closely related subspecies. The upper limits of variation of the *absona* subcomplex are beyond the upper limits of the *acuta* subcomplex but the lower limits of the former overlap the upper limits of the latter. The area of distribution of the former is also to the south of the latter. Some taxonomists would

consider the two southern populations as distinct species but the fact that some of the smaller specimens of the *absona* are almost identical with some of the larger specimens of the *acuta* subcomplex seems to indicate a similar genetic background. The fact that they can be separated as subspecies appears to be due either to incomplete isolation, that is enough nevertheless, to have allowed different gene-frequencies to express themselves in the majority of the members of the various populations, or the expression of these different gene-frequencies or arrangements may be determined by natural selection along somewhat the same lines as indicated by Dobzhansky (1947) in wild populations of *Drosophila*.

Eurytoma acuta acuta n. subsp.

Fig. 4

Female.—Black. Length 4.1–5.8 mm. (aver. 4.7). Abdomen 2.5–3.3 mm. long (aver. 2.8); exposed portion of the dorsal valves 0.37–0.50 mm. in length (aver. 0.42) which is about 58% of the length of segment 6; segment 6, at widest point, 0.55–0.87 mm. (aver. 0.72); thus segment 6 averages about 25% of the length of the abdomen, and 1.7 times the length of the dorsal valves. Internal genitalia strongly developed; arch of the stylets close to a vertical plane; dorsal valves, black and bend dorsally, anteriorly, at less than a right angle as do ventral valves which expand into a broad plate that bends slightly posteriorly; plate averages 0.33 mm. at its widest point (range 0.25–0.37); angle formed by the tangent and horizontal lines equals 37°; length of genitalia averages 2.6 mm. (range 2.0–2.8) and height averages 1.6 mm. (range 1.2–1.9). Propodeum with a shallow median furrow that is bounded by carinae dorsally that play out about half way down; furrow widest at top and narrow ventrally; two large rectangular depressions at top of furrow, separated by a central carinae that becomes vague below rectangles; rest of furrow crossed by fine irregular horizontal carinae; deep pit at base of furrow which may be divided into two foveae. Antennae with upper half of scape black, rest brownish-yellow; in a few specimens all black. Legs usually with slight amounts of black to dark-brown infuscation towards base of yellow-brown fore and mid-femurs and on outer face of fore and mid-tibiae; hind-femurs and tibiae always with black to dark-brown, medially; tips yellowish-brown; less often fore-legs all brownish-yellow. Wing veins brown to light-brown in color; marginal vein broad; length 0.37–0.47 mm. (aver. 0.39); length of postmarginal vein 0.30–0.40 mm. (aver. 0.36); thus the marginal averages 0.03 mm. longer than the postmarginal in most specimens but the two may be equal in length in a few specimens; stigmal club approximately square in outline.

Male.—Length 3.0–4.0 mm. (aver. 3.4). Legs most often with small amounts of black infuscation on base of fore-femurs and outer face of fore-tibiae; more extensive for mid-femurs and tibiae; hind-femurs and tibiae black except tips; less often fore and mid-legs entirely light brownish-yellow. Scape usually black or dark-brown for upper one-third or three-fourths; base yellowish-brown. Wing veins brown; marginal vein broad, heavily chitinized, averaging length 0.40 mm. (range 0.37–0.45); postmarginal vein averaging 0.34 mm. (range 0.32–

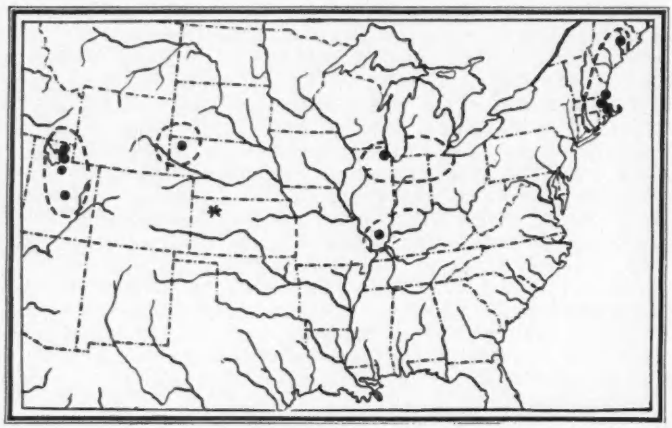
0.35); thus the marginal always averages about 0.06 mm. longer than the postmarginal. Stigmal club deeply rectangular to square in outline.

Types.—Topotypical, 27 females and 11 males; ***holotype*** female, ***allotype*** male and ***paratopotypes*** of both sexes in the United States National Museum. ***Paratopotypes*** in the Bugbee Coll.

Type Locality.—Price, Utah; April 20, 1920.

Host.—Diplolepis tuberculatrix xerophila on *Rosa.*

Paratypes, not topotypical.—UTAH, Provo, April 18, 1920, from galls of *Diplolepis tuberculatrix xerophila*, 10 females; Logan, May 1, 1933, from rose gall, W. L. Thomas coll., 1 female; Murray, collected October 15, 1913, issued May 26, 1914 from *Diplolepis arefactus* gall on *Rosa*, Timberlake coll., no. 420c, 6 females; Green River, April 21, 1920, from *D. tuberculatrix* var. *xerophila* on *Rosa*, 2 females; Wellsville,

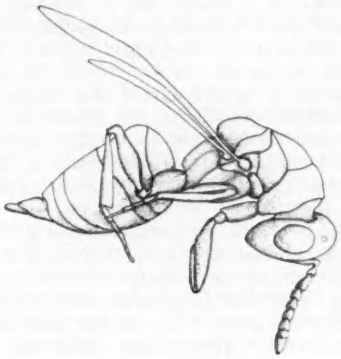


MAP II

Distribution of Eurytoma calcarea and its subspecies

galls collected September 5, 1927, males and females emerged May 24, 1928 from galls of *D. xerophila*, Kinsey det., on *Rosa*, B. and H. Pack coll., 4 females and 2 males; Brigham, May 7, 1933, reared from Rose gall, Major J. Jones coll., 2 males. COLORADO, Aspen, 6 miles east, galls collected on August 23, 1929, male and female emerged April 26, 1930 from galls of *D. tuberculatrix*, Kinsey det., on *Rosa*, Kinsey coll., 1 female and 25 males; Glenwood Springs, April 22, 1920, from galls of *D. coloradensis* on *Rosa*, 2 females and 2 males; Durango Co., May 1899, Aug. 1899, no. 8510 and 8511, on *Rosa fundleri*, C. C. Baker, from galls of *Diplolepis arefactus*, 4 females.

Range.—West-central part of Colorado, west of the Great Divide, and the central and northern highlands of Utah, east of Great Salt Lake (Map I.). More extensive collections will probably extend its range northward into the mountain country of southeastern Idaho and southwestern Wyoming.



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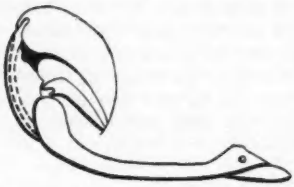

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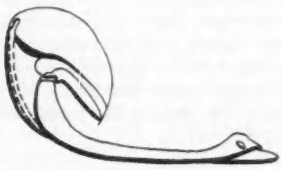

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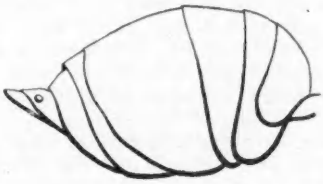

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FIG. 9. Female of *Eurytoma calcarea*. 18×. FIG. 10. *E. calcarea*, female genitalia. Enlarged to 75 mm. FIG. 11. *E. longavena*, female genitalia. Enlarged to 75 mm. FIG. 12. *E. longavena*, female abdomen. Enlarged to 75. mm. FIG. 13. *E. longavena*, outline of marginal, postmarginal and stigmal veins. 50×.

Remarks.—*E. acuta* is a close western relative of the eastern *E. discordans*. It resembles *E. discordans* in its general appearance (total length, length of the ninth abdominal segment, shape and length relationships of the abdomen, etc.). It can be distinguished from *E. discordans*, however, by the color of the scape which is either all black or the upper-half black and the lower-half yellowish-brown; the darker brown color of the wing veins; broader marginal vein; the almost square stigmal club (fig. 4); the wide median furrow of the propodeum that narrows ventrally and the black infuscation that usually occurs on all of the legs.

The host relations of *acuta*, appear somewhat varied. It is recorded from *Diplolepis tuberculatrix xerophila*, *D. t. arefacta* and *D. t. coloradensis*. These hosts are either varieties or forms of *D. tuberculatrix* (Kinsey and Ayers, 1922) and their relationships are very close. The slight differences that separate the various host forms and varieties appear to be detectable if large enough series are available. Similar differences do not seem to exist among the parasites. Thus the relationship between host and parasitic species is very close but below the species (forms and varieties of Kinsey) the parasites fail to show the same degree of differentiation. The failure of parasites to follow the same evolutionary paths as their hosts in all details has been shown before in the genus *Eurytoma* (Bugbee, 1941a: 387–388, 1944a: 26 and 1944b: 421–422).

Eurytoma acuta intermedia n. subsp.

Fig. 5

Female.—Can be distinguished from other subspecies of *E. acuta* by its smaller size; length 3.7–4.9 mm. (aver. 4.2); the shorter exposed tips of the dorsal valves averaging 0.34 mm. in length (range 0.27–0.40); shorter abdomen (length 2.0–2.8 mm., aver. 2.3), shorter sixth abdominal segment which averages in width, from a lateral view, 0.61 mm. (range 0.55–0.70). Wing veins are lighter yellowish-brown and the marginal vein averages 0.36 mm. in length (range 0.30–0.40), while the postmarginal vein averages 0.36 mm. (range 0.30–0.40); thus the two veins are usually equal in length; stigmal club is never square but may be deeply rectangular in outline.

Male.—Differs from other subspecies in the color of the scape which has the lower half yellow to yellowish-brown and the upper half black; the all yellowish-brown fore and mid-femurs and tibiae; the light-yellow wing veins; the mediumly stout marginal vein which ranges in length from 0.35–0.42 mm. (aver. 0.39), and the postmarginal vein whose length is 0.32–0.42 mm. (aver. 0.37); thus the two veins are most often equal in length. Stigmal club as in the female.

Types.—Topotypical, 5 females and 8 males; *holotype* female and *allotype* male in the United States National Museum. *Paratypes* of both sexes in the Bugbee Collection.

Type locality.—Beach, North Dakota. C. N. Ainslie coll., no dates given.

Host.—Reared from "smooth" rose gall; species not given.

Range.—The southwestern part of the state of North Dakota between the Little Missouri river to the east and Beaver creek to the west.

Remarks.—The typical gall of *Diplolepis tuberculatrix* species has the surface covered with sharp spines (Kinsey and Ayres, 1922:145). There are a few varieties, however, such as *D. t.* var. *similis*, which have smooth, spineless galls (Kinsey and Ayres, 1922:147) but this species range is in western Wyoming some 500 miles from Beach, N.D. The territory between these two points would effectively isolate the Beach population from the Point of Rocks, Wyoming population. The gall of *D. globuloides* is also a smooth surfaced gall which fits the description of the host gall of *E. acuta intermedia*, but *intermedia* is closer to *E. acuta* than to *E. discordans*, the parasite bred from *D. globuloides*. It was pointed out in the discussion of the host relationships of *E. discordans* that *D. globuloides* galls are believed to be modified inquiline inhabited galls of some unknown true cynipid gall maker probably closely related to or the same as *D. tuberculatrix*. Thus one of the modifications of the inquiline inhabited *globuloides* gall seems to be the loss of its spines. This same modification occurs in *D. tuberculatrix* galls inhabited by inquilines which have been erroneously described as *D. neglecta* galls (Kinsey and Ayres, 1922:160). Therefore it seems quite likely that the "smooth" galls from Beach are modified inquiline inhabited galls and that *E. acuta intermedia* is a parasite of a species of inquiline or other chalcid parasite in the galls, rather than on a true cynipid gall-making species of the *Diplolepis tuberculatrix* group.

E. acuta intermedia superficially resembles *E. discordans* in the light-yellowish color of the wing veins, the equal length of the marginal and postmarginal veins, the rectangular shape of the stigmal club (fig. 5) and the variation in the color of the scape which may be all yellow or lower half yellow and the upper half black. On the other hand it has much more in common with the *E. acuta* complex of subspecies. The stigmal club is never as narrowly rectangular as in *E. discordans* and in the majority of specimens may be deeply rectangular; the scape of the antennae is most often bicolored (lower half yellow and upper half black); there is black infuscation on the femurs and tibiae of most specimens, etc. It appears to be somewhat intermediate between *E. discordans* and *E. acuta acuta* but in examining the specimens at hand it is obvious that the Beach material is neither the same as *E. acuta* or *E. discordans*. It averages smaller in all its measurements than either of the other two and the rather constant relation of the equality in length of the marginal and postmarginal veins in both males and females, as well as its isolated range, determine its subspecific status in the *E. acuta* subcomplex.

Eurytoma acuta ramosa n. subsp.

Fig. 6

Female.—Differs from *E. acuta acuta* chiefly in the darker yellowish-brown color of the legs with more black infuscation, especially on the fore and mid-legs; the slightly longer dorsal valves which average 0.46 mm. in length (range 0.37–0.50); the greater difference in the ratio of the length of the marginal and the postmarginal veins; the marginal vein averages 0.42 mm. (range 0.35–0.47) and the postmarginal averages 0.35 mm. (range 0.27–0.42); thus the marginal is always longer than the postmarginal by an average of 0.07 mm. Length average 4.7 mm. (range 3.9–5.8).

Male.—Shows much the same differences as in the female except in the color of the legs. The fore and mid-legs are most often all light yellowish-brown with slight black infuscation on mid-tibiae of a few specimens; hind-legs with the femurs and tibiae black to dark-brown except yellowish-brown tips; base of fore-coxae may be tinged with yellow. Marginal vein averaging in length 0.40 mm. (range 0.35–0.47) and postmarginal averaging 0.35 mm. (range 0.25–0.40); scape of the antennae always with lower half yellowish-brown and upper half black or dark-brown. Average length, 3.1 mm. (range 2.1–4.1).

Types.—Topotypical, 13 females and 7 males; ***holotype*** female, ***allotype*** male, and paratypes in the Bugbee Collection. Paratypes of both sexes in the United States National Museum.

Type locality.—Grand Rapids, Michigan. Galls collected on October 25, 1928; males and females emerged June 1, 1929, Benner coll.

Paratypes, not topotypical.—CANADA: Aweme, MANITOBA, June 6, 1906, parasite from rose gall No. 1, Criddle coll. Entomological Branch, Ottawa, Canada, 4 females and 2 males; Oxbow, SASKATCHEWAN, May 5, 1907, rose gall, Fred K. Knab coll., 2 females and 1 male. MINNESOTA: Eaglenest, collected September 1944, W. V. Balduf coll., emerged July 25, 1945 from "spiny" rose galls, 1 female. MICHIGAN: Cheboygan, collected October 3, 1927, Kinsey coll., males and females emerged May 30, 1928 from galls of ***Diplolepis tuberculatrix*** variety, Kinsey det., 2 females and 3 males.

Range.—From central and northern Michigan, northwestward through Minnesota, into the southern part of Manitoba and Saskatchewan, Canada. If it follows its probable host (see below) it would be expected to occur in northern Illinois.

Host relationships.—No host species is designated on the labels accompanying the specimens, except that the host is a member of the ***Diplolepis tuberculatrix*** complex. However, in some material sent in for determination by Mr. S. E. Lienk, was a single female specimen of this species. Accompanying the insect was a specimen of the "spiny" rose gall referred to on the label from Eaglenest, Minnesota and it is a typical gall of ***Diplolepis tuberculatrix multispinosa.*** This locality is well within the range of ***D. t. multispinosa*** as recorded by Kinsey and Ayres (1922;148). Whether ***E. acuta ramosa*** is parasitic on the true gall-maker, an inquiline species, or some chalcid parasite of the gall-maker cannot be determined from the paucity of data available.

Remarks.—This subspecies is close to ***E. acuta acuta*** but may be distinguished from it by the characteristics mentioned in the foregoing description. Its range, especially in Michigan, overlaps that of ***E. discordans*** but there is no evidence from the material that the two interbreed.

Eurytoma acuta absona n. subsp.

Fig. 7

Female.—Differs from typical *acuta* and other subspecies in its much larger size. Average length, 6.0 mm. (range 5.2–6.6). Longer sharply pointed dorsal valves averaging 0.56 mm. in length (range 0.50–0.62). Larger, strongly compressed abdomen averaging in length 3.6 mm. (range 3.3–3.8); wider sixth abdominal segment, averaging 0.87 mm. at

its widest point (range 0.75–0.92); yellowish-brown and mediumly stout wing veins; marginal vein averages in length 0.49 mm. (range 0.42–0.55) while the postmarginal vein averages 0.42 mm. (range 0.37–0.50); thus the marginal is usually longer than the postmarginal by an average of 0.07 mm.; stigmal club square to deeply rectangular. Scape most often all yellow or slight blackish tinge at tip only in a few specimens. Black infuscation on hind-femurs and tibiae; fore- and mid-legs all yellow to yellowish-brown.

Male.—Length averages 3.7 mm. (range 3.4–4.1); scape with lower half yellowish-brown, upper half black. Legs most often with fore and mid-legs light yellowish-brown and dark-brown to black infuscation on hind-femurs and tibiae only; occasionally slight amounts of black infuscation on base of fore and mid-femurs and outer faces of tibiae. Wing veins dark-brown to yellowish-brown; mediumly thick and stout; marginal vein averaging 0.42 mm. in length (range 0.40–0.47) and postmarginal averaging 0.38 mm. (range 0.37–0.40); thus the marginal is usually longer than the postmarginal; stigmal club may be square or rectangular in outline.

Types.—Topotypical, 11 females and 4 males; ***holotype*** female, ***allotype*** male and ***paratypes*** in the United States National Museum. Paratypes of both sexes in the Bugbee Collection.

Type locality.—Colorado Springs, Colorado, B. T. Harvey coll. 12020*r*, Hopk. U. S.

Host.—Reared June 10, 1914 by W. Middleston from *Lytorhodites* (= *Diplolepis*) ***multispinosa*** (Kieffer) on rose. Also a small series from Colorado Springs with the same notation on the labels except that the specimens emerged on July 17, 1914. No host plant is given but one label reads "rosebush."

Paratypes, not topotypical.—COLORADO: Westcliffe, L. H. Weld coll., 15636*b*, Hopk. U. S. Reared May 15, 1922 from an unidentified gall on rose, 5 females and 1 male.

Range.—Along the eastern slopes of the Central Rockies in Colorado.

Host relationships.—The only host designated is *Lytorhodites* (= *Diplolepis*) ***multispinosa***. This seems doubtful as Kinsey and Ayres (1922;148) have shown that *D.* ***multispinosa*** ranges in the north central United States (see discussion under *E.* ***acuta ramosa***). It seems more likely that the host gall is probably ***Diplolepis tuberculatrix tuberculatrix*** that Kinsey records from both Colorado Springs and Westcliffe. The exact host of *E.* ***acuta absona*** within the gall is not determinable from the data.

Remarks.—This species in its grosser characteristics is related to *E.* ***acuta acuta***. It differs from typical ***acuta*** primarily in its larger size and this is carried over into other characteristics so that all measurements show higher averages. For instance, the longer abdomen is reflected in longer dorsal valves and wider sixth abdominal segment. The scape is most often all yellowish-brown instead of half black and half brown and the fore and mid-legs are all yellowish-brown. The broader and heavier marginal vein is also characteristic (fig. 7.).

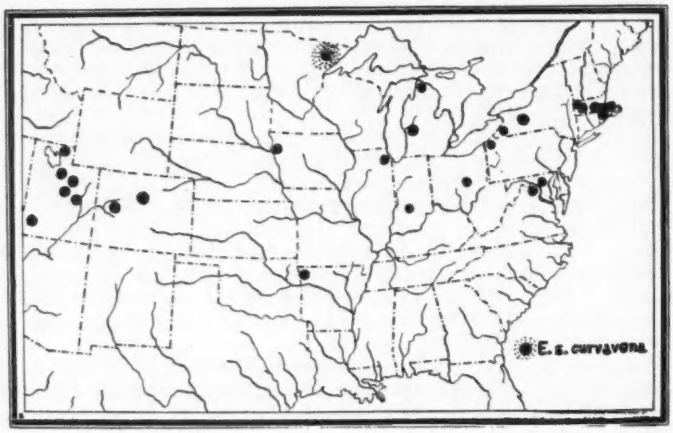
E. ***acuta absona*** is still closer to the subspecies that follows. The characteristics that separate the two populations are discussed under that subspecies.

Eurytoma acuta gemina n. subsp.

Fig. 8

Female.—Similar to *E. acuta absona* but differs from it in the relationship of the length of the marginal and postmarginal veins; the marginal averages 0.44 mm. in length (range 0.37–0.47) while the postmarginal averages 0.46 mm. (range 0.37–0.52); thus the postmarginal is either equal to or longer than the marginal. Length averages 5.7 mm. (ranges 4.5–6.3).

Male.—The same relationship holds for the males. The marginal aver. 0.38 mm. in length while the postmarginal averages 0.39 mm.; veins deep brown in color.



MAP III

Distribution of Eurytoma spongicola

Types.—Topotypical, 3 females and 2 males; *holotype* female and *allotype* male in the United States National Museum. *Paratypes* of both sexes in the Bugbee Collection.

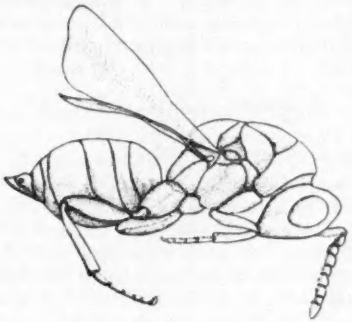
Type locality.—Flagstaff, Arizona. Hopk. U. S., 15600*c*, L. H. Weld coll. Reared May 8–15, 1918 and June 1–17, 1918.

Host.—No host designation is given for any of the limited series. It can be expected, however, to be associated with galls of a *Diplolepis tuberculatrix* variety on *Rosa.*

Paratypes, not topotypical.—ARIZONA: Williams, No. 356, from stem gall on rose, 2 females and 2 males; Prescott, Hopk. U. S., 15600*c*[1], reared April 29 and May 8, 1918, *Rosa* species, L. H. Weld coll., 2 females and 1 male.

Range.—Known only from the three localities cited above in the western half of the state of Arizona, south of the Grand Canyon.

Remarks.—This subspecies is very close to the preceding subspecies in all its characteristics except the relationship of the length of the



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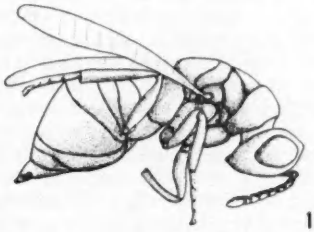

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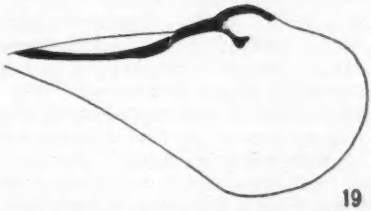

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FIG. 14. *E. spongiosa*, female. 18×. FIG. 15. *E. spongiosa*, female genitalia. Enlarged to 75 mm. FIG. 16. *E. spongiosa*, female genitalia. Enlarged to 75 mm. FIG. 17. *E. s. curvavena*, female. 18×. FIG. 18. *E. s. curvavena*, female genitalia. Enlarged to 75 mm. FIG. 19. *E. s. curvavena*, outline of wing showing the bent condition of the postmarginal vein, which occurs in some specimens of this species.

marginal and postmarginal veins (fig. 8). Geographically it is separated from *absona* by high mountains and broad expanses of desert. The one wing character, however, is remarkably constant, at least for the specimens at hand.

Eurytoma incerta Fullaway

Map I

1912. Jour. New York Ent. Soc. 20(4): 274–281.

An attempt to locate the types of this species has been unsuccessful. A search of the insect collection by G. F. Ferris at Stanford University where the types were deposited, yielded a number of specimens labeled *E. incerta*. None of them bore the correct Lot number 499, subscript 23 assigned to the types at the end of the original description by Fullaway. Dr. Ferris forwarded to me and Mr. A. B. Gahan of the United States National Museum all the specimens that might have any connection with this species but we were unable to find among the material any examples that seemed to fit the original description. Thus we must conclude that, for the present at any rate, the types of *E. incerta* (according to Fullaway 4 females and 1 male) must be lost or the correct labels have been lost or switched so that none of the specimens can be definitely assigned as types of *E. incerta*.

On the other hand, there are several clues in the original description that suggest that *E. incerta* of Fullaway is the same as some material that I have from northern California and southern Oregon from *Diplolepis tuberculatrix* galls or a subspecies of the same. The characters which suggest this are size, shape and lateral compression of the abdomen, distribution of black infuscation on the legs and the sculpturing on the surface of the sixth abdominal segment (the fifth segment of the original description, assuming that Fullaway counted the petiole as the first abdominal segment) which extends from the ventral surface of the segment clear to the dorsal surface. The notation of the host "from a large pointed gall on rose" might be applicable to galls of a *Diplolepis tuberculatrix* variety or a *D. neglectus* variety (inquiline inhabited modified galls of *D. tuberculatrix*). This inference is further strengthened by the fact that my material represents a complex, that is restricted to the west coast west of the Sierra Nevadas and the type locality of *E. incerta* is Stevens Creek, near Cupertino, which is not far from the location of Stanford University.

Thus it would seem advisable to label my material *E. incerta* instead of describing it as a new species. The complex can be divided into two subspecies and a redescription of *E. incerta* based on my material as well as descriptions of the new subspecies follows.

Female.—Black. Length averages 4.3 mm. (range 3.5–5.2). Abdomen oval from lateral view; not sharply arched dorsally, anteriorly; lateral compression not excessive so that greatest width is near middle in cross section, not in upper third; length of abdomen averaging 2.5 mm. (range 1.8–2.8); sixth abdominal segment at widest point averaging 0.69 mm. (range 0.62–0.77); segment 6 averaging about 27% of the length of the abdomen and 2.4 times the length of the dorsal valves; fine scaling on segment 6 covers entire lateral surface basally but recedes towards anterior margin, dorsally; ninth abdominal segment

(exposed portion of dorsal valves) on same level or extend only slightly above the horizontal axis of the abdomen; not elongate but short and broad; averaging 0.29 mm. in length (range 0.20–0.35); or about 42% of the length of segment 6: internal genitalia mediumly developed; stylet arch in an oblique plane; dorsal valves black and maintain same width for horizontal length, turn dorsally anteriorly at less than a right angle, and do not bend posteriorly; genitalia averaging in length 2.3 mm. (range 2.0–2.6); height 1.4 mm. (range 1.1–1.6); ventral valves expand anteriorly into a brownish colored plate that averages 0.28 mm. in width at widest point (range 0.20–0.32). Thorax with black tegulae; propodeum with a shallow to deep and narrow medium furrow that may be wider at top than ventrally or about mid-way between top and bottom; usually two large rectangular to square areas at top of median furrow and below these, are irregular horizontal ridges outlining smaller rectangles; at base of furrow is an undivided deep pit; areas lateral to furrow with deep punctures dorsally that fade into fine pitting ventrally. Antennae with the scape most often black except extreme base; less often lower-half yellowish-brown and upper half black funicle filiform, consisting of seven distinct segments which may be longer than wide or become progressively shorter so that distal segments, 4, 5, and 6 are approximately square; sixth segment may be closely applied to the seventh or differentiated from it by a clear annulation; last segment forms a bluntly pointed terminus. Legs with black on all femurs and tibiae, flares up from base on fore-femur to cover one-half to three quarters of outer surface; smudge only on outer face of fore-tibiae; more extensive on mid-legs and femurs and tibiae of hind-legs usually black except tips. Wing veins brownish-yellow; marginal averaging in length 0.39 mm. (range 0.32–0.42); postmarginal averaging 0.35 mm. (range 0.25–0.40); thus marginal is usually longer than the postmarginal; stigmal club square to rectangular, never linear.

Male.—Length averages 3.3 mm. (range 2.6–4.0). Scape of antennae most often all black except base; less often lower half yellowish-brown and upper-half black. In most specimens front legs are all yellowish-brown. Wing veins brown to brownish-yellow; marginal vein broad and stout; averaging in length 0.37 mm. (range 0.30–0.42); postmarginal averaging 0.31 mm. (range 0.25–0.37); thus marginal is always longer than postmarginal; stigmal club from almost square to rectangular.

Types.—Detailed under the subspecies described below.

Range.—Along the west coast from the state of Washington southward to lower California. The localities recorded under the various subspecies are all located on the western slopes of the Pacific Coastal Range (Map I).

Host relationships.—This species is bred from galls on various species of the genus *Rosa* caused by several varieties of the *Diplolepis tuberculatrix* (Cockerell) complex (Kinsey and Ayres, 1922) and *Diplolepis politus* var. Ashmead. The exact hosts are given in more detail under the descriptions of the subspecies.

Remarks.—*E. incerta*, along the west coast, is the equivalent of *E. acuta* to the eastward. The whole *incerta* complex shows closer affinities with *E. acuta acuta* than to any of the other subspecies of the *acuta* group. This suggests that additional subspecific populations of

either the *acuta* or *incerta* complexes should occur across the northern intervening territory (Utah, Montana, and Oregon) as connecting links between the two, rather than across the southern parts of Arizona and California. *E. incerta* has much less in common with *E. acuta gemina* or *E. acuta absona* (from western Arizona and eastern Colorado)

E. incerta and its subspecies resemble *E. acuta* in their general shape, although they run smaller in most of their measurements. Thus the abdomen averages shorter, sixth abdominal segment does not average as wide but is actually wider in relation to the length of the abdomen than in *E. acuta*. Exposed tips of the ventral valves are shorter and more bluntly pointed. Propodeal median-furrow is usually narrower and deeper and the scape is more often all black than lower half yellowish-brown and upper half black. The geographic range is distinctive as well as the fact that its hosts are west coast species or varieties of *Diplolepis tuberculatrix* complex, and *D. politus*.

Two subspecies are described in the *E. incerta complex*. One occurs in Oregon and the northern half of California and the other is found in extreme southern California (Map I).

Eurytoma incerta incerta Fullaway

Female.—Length averaging 4.4 mm. (range 3.5–5.1). Shape of abdomen, measurements of the width of the sixth segment, length of the abdomen and of the exposed tips of the ventral valves, typical of the *incerta* complex. Genitalia averaging in length 2.3 mm. (range 2.0–2.6) and in height 1.5 mm. (range 1.1–1.6); expanded, anterior, brownish plate of dorsal valves averages 0.28 mm. (range 0.20–0.32) at widest point; whole structure more robust and stouter than in the other subspecies of *incerta* complex. Propodeum with the median furrow shallow and broad; widest point about one-third of the way down from the top in most specimens; no foveae in pit at base of furrow. Antennae with the funicle, filiform, 7-jointed, and all longer than wide; scape most often all black except base; in a few specimens upper half black and lower half, yellowish-brown. Wing veins yellowish-brown; marginal vein broad and stout in most specimens; relation of length of the marginal to the postmarginal veins characteristic of the complex. Marginal averaging 0.38 mm. in length (range 0.32–0.42) and postmarginal averaging 0.34 mm. (range 0.25–0.40).

Male.—Black. Length averaging 3.1 mm. (range 2.6–3.9). Wing veins as in the female except that the marginal and postmarginal veins are shorter; marginal averaging 0.34 mm. (range 0.30–0.42) in length and the postmarginal averaging 0.30 mm. (range 0.25–0.37).

Types.—Original types of Fullaway (4 females and 1 male) presumedly lost or unidentifiable. *Neotypes:* 23 females and 20 males. Neotype female and neallotype male plus paratypes of both sexes in the United States National Museum. Paratypes of both sexes in the Bugbee Collection.

Neotype locality.—Junction City, Oregon. Galls collected on April 9, 1920 by A. C. Kinsey.

Host.—Labels read, from *Diplolepis neglectus* (= *D. tuberculatrix*), Kinsey det., on *Rosa* species (see remarks, below) and *Diplolepis politus* var. on *Rosa*.

Range.—Along the west coast from the state of Oregon southward to central California.

Additional localities.—CALIFORNIA: Palo Alto, March 13–19, 1920, bred from galls of *Diplolepis neglectus* (Gillette) (= *D. tuberculatrix*) on *Rosa* species; 2 females and 4 males; Salinas, April 8–19, 1920, bred from galls of *Diplolepis neglectus* (= *D. tuberculatrix*) on *Rosa* species, 4 females and 10 males. OREGON: Ashland, April 6, 1920, bred from galls of *Diplolepis politus* var. on *Rosa*, 7 females.

Remarks.—This subspecies has much in common with *E. acuta acuta* as pointed out in the remarks following the preceding description of *E. incerta*. It is indicated above that the host galls (*Diplolepis neglectus* (Gillette)), of this species, are interpreted as modified "inquiline-inhabited galls of *D. tuberculatrix*" (Kinsey and Ayres, 1922). In this case then it is quite clear that, the eurytomid species must be a primary parasite of the inquiline inhabitant or a secondary parasite of other species of primary parasites of the inquiline. Since other species of chalcids are bred from the galls the latter case cannot be completely ruled out until the life-histories and other relationships of the various species in the galls are examined.

If *neglectus* galls are modified-inquiline galls of *D. tuberculatrix* then, according to Kinsey and Ayres, the variety of *tuberculatrix* host that occurs in the area covered by *E. incerta incerta* is probably *Diplolepis tuberculatrix californica* (Beutenmuller) from the Palo Alto, Salinas, Berkeley, and Santa Rosa vicinity.

Eurytoma incerta varia n. subsp.

Female.—Differs from typical *incerta* in averaging smaller in its measurements. Length averaging 4.1 mm. (range 3.9–4.5). Antennae with the scape most often all black; funicle 7-segmented but sixth segment is closely applied to the seventh so that it appears as part of it; last segment forms a slightly enlarged, blunt club; preceding segments become progressively shorter, distally, until 4, 5 and 6 are approximately square. Propodeum with a narrow, deep median furrow that narrows basilly to about half of its width at top. Legs with black on all femurs and tibiae. Marginal vein not as stout or broad as in *incerta;* more linear. Genitalia not as robust as in *incerta;* averaging 2.0 mm. in length, 1.3 mm. in height, and expanded portion of ventral valves, anteriorly, averaging 0.25 mm. at widest point.

Male.—Unknown as there were no males in the small series.

Types.—Topotypical, 4 females; *holotype* female and paratypes in the United States National Museum. Paratype female in Bugbee Collection.

Type locality.—Descanso, California. Galls collected on February 23, 1920.

Host.—From galls of *Diplolepis tuberculatrix descansonis* on *Rosa* species.

Range.—The single locality is in the Cuyamaca Mountains of the southwestern corner of California. Probably restricted to this area and the extension of the mountains into Lower California and northward into the mountains of San Jacinto environs (see remarks below).

Paratypes, not topotypical.—CALIFORNIA: San Jacinto Mountains,

galls collected on February 28, 1920, bred from galls of ***Diplolepis tuberculatrix sierranensis*** on ***Rosa*** species, 5 females.

Remarks.—This subspecies is close to the more northern ***incerta*** but differs from it in the characteristics stressed in the short description. The intervention of extensive desert between its range and that of ***E. acuta gemina*** to the east in Arizona has effectively isolated ***varia*** from any contact with the former. The same situation occurs for its host (***Diplolepis tuberculatrix descansonis***) which has its closest relatives to the north rather than the east (Kinsey and Ayres, 1922:159–160).

The material from the San Jacinto Mountains is very close to ***varia*** but still exhibits some indications that it may be a distinct subspecies. The exposed tips of the dorsal valves average shorter (0.24 mm.). The median furrow of the propodeum, although narrow and deep like ***varia***,

MAP IV

Distribution of E. obtusilobus Ashm.

remains wider ventrally so that the lateral limiting carinae remain parallel to each other. Its distinct host and range suggest also that with an adequate series its status as a subspecies of the ***incerta*** complex might be indisputable established. At present it seems best to include it under ***varia*** which it resembles very closely.

Eurytoma terrea n. sp.

Fig. 25

Female.—Black. Length averages 4.1 mm. (range 3.9–4.6). Abdomen plump; average length 2.3 mm. (range 2.0–2.5); sixth abdominal segment, at widest point averaging 0.68 mm. in width; sculpturing of fine pits on sixth abdominal segment covers lateral and dorsal surface from anterior to posterior margin; ninth abdominal segment plus ventral valves of the ovipositor in line with the horizontal axis of the abdomen;

ninth segment (dorsal valves of ovipositor) short and broad; average length 0.21 mm. (range 0.17–0.27); its spiracle round. Internal genitalia with broad dorsal valves that bend dorsally, anteriorly only slightly, at much less than a right angle; ventral valves, anteriorly bend upward and extend only slightly above anterior end of dorsal valves; stylet arch in a horizontal plane; average length of genitalia 2.1 mm. (range 2.0–2.3); average height 0.95 mm.; expanded anterior plate of ventral valves averaging 0.17 mm. at widest point. Thorax with tegulae black. Propodeum with a shallow median furrow; widest at top and narrows

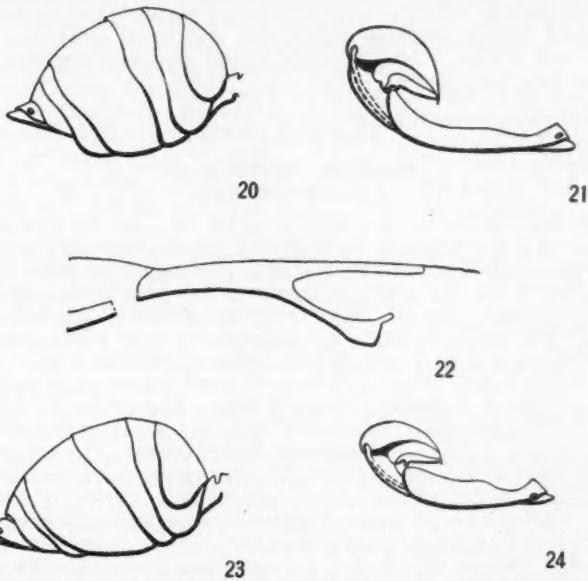


FIG. 20. *Eurytoma obtusilobae*, female abdomen. Enlarged to 75 mm. FIG. 21. *E. obtusilobae*, female genitalia. Enlarged to 75 mm. FIG. 22. *E. obtusilobae*, outline of marginal, postmarginal and stigmal veins. 50×. FIG. 23. *E. imminuta*, female abdomen. Enlarged to 75 mm. FIG. 24. *E. imminuta*, female genitalia. Enlarged to 75 mm.

toward base; lateral carinae, separating median furrow from lateral areas weakly developed dorsally becoming indistinct ventrally; lateral areas crossed by fine horizontal ridges with surface between delicately shagreened; similar sculpturing in median furrow; rectangular pit at base of furrow. Antennae with the scape black or basal fourth yellow and rest black. Black infuscation on femurs and tibiae of all legs. Wing veins brown to brownish-yellow; stigmal club small, triangular to rectangular in shape with rounded bottom; marginal vein mediumly broad, averaging 0.44 mm. in length (range 0.37–0.50); postmarginal vein long and pointed, averaging 0.41 mm. (range 0.37–0.50); thus post-

marginal and marginal often equal in length or the postmarginal is less than the marginal by not more than 0.04 mm.

Males.—No males represented in the small series.

Types.—Topotypical, 7 females; ***holotype*** female and ***paratypes*** in the United States National Museum. Paratypes in the Bugbee Collection.

Type locality.—Ashland, Oregon. Collected April 6, 1920.

Host.—*Diplolepis politus* var. on *Rosa*.

Range.—Known only from the one locality in the southwestern part of Oregon.

Remarks.—This species is close to ***Eurytoma incerta*** but differs from it in the shorter, broader ninth abdominal segment, the more weakly developed female genitalia with much less dorsal extension of the dorsal and ventral valves, anteriorly, and the very shallow median furrow of the propodeum.

Calcarea Group

Eurytoma calcarea n. sp.

Figs. 9 and 10; Map II

Female.—Mostly black. Length ranges from 2.5–4.6 mm. with an average of 3.6. Abdomen oval from a lateral view; plump; lateral compression slight so that in cross section the greatest width is across the middle of the oval outline instead of in the upper third; length of the abdomen ranges from 1.6–2.6 mm. with an average of 2.1; hairs on the dorso-lateral aspect of segment 6, average 5 (range 2–10); segment 6, at widest point averaging 0.64 mm. (range 0.50–0.80) which is about 30% of the length of the abdomen; exposed tip of the dorsal valves (last abdominal segment) short and blunt; average length 0.23 mm. (range 0.15–0.32); thus abdomen is about 9.1 times the length of the dorsal valves; anterior abdomen not arched sharply above the petiole and its dorsal surface slopes gradually back to the pointed ventral valves; dorsal and ventral valves project only slightly above the horizontal axis of the abdomen. Internal genitalia range in length from 1.8–2.3 mm. (aver. 1.9); height ranges from 1.0–1.3 mm. (aver. 1.1); anterior expanded plate of the ventral valves ranges from 0.18–0.24 mm. in width (aver. 0.20); plate does not bend posteriorly upon itself; stylet arch half way between a vertical and horizontal plane; dorsal valves black and uniformly narrow for horizontal length; thorax with the tegulae black or dark brown. Propodeum either with a wide, shallow median depression showing no sign of distinct lateral carinae or a narrow median furrow that is sharply marked off from lateral areas by lateral carinae; median furrow may be wider at the top or just below the top than at the bottom, or sides may be approximately parallel; pit at the base of furrow not divided into foveae; lateral to top or median furrow, are prominent carineae that curve ventrally about one-fourth to one-third length of furrow and then swing dorsolaterally, delimiting shallow depressions at top of propodeum and lateral to median furrow; antennae with scape either all yellowish-brown, lower half brown and upper half black or all black to dark brown; flagellum filiform and 7-segmented; first segment longer than wide and succeeding segments becoming shorter until 4 and 5 may be almost square, or all segments longer than

wide; 6 segment closely applied to 7 but separated from it by a distinct annulation; 6 plus 7 form a bluntly pointed terminal unit that may be a slightly swollen club. Legs with the coxae either all black or with a yellowish-brown tinge to lower part of fore-coxae; fore-legs may be all yellowish-brown or with varying amounts of brown to black infuscation on femurs and tibiae; mid-legs usually and hind-legs always with some brown to black infuscation on femurs and tibiae. Wing veins light yellow in a few specimens but most often brown; marginal vein most often broad and heavily chitinized, less often thin; average length 0.35 mm. (range 0.25–0.45); postmarginal vein averages 0.30 mm. in length (range 0.20–0.45); in most instances marginal is longer by about 0.05 mm. than postmarginal but occasionally they may be equal; stigmal club rectangular to square, never linear.

Males.—Mostly black. Length 1.7–3.7 mm. (aver. 2.7); scape of antennae, legs, and wing veins with same color variation as in the female. Marginal vein ranges in length from 0.25–0.40 mm. (aver. 0.32); postmarginal vein ranges from 0.20–0.35 mm. (aver. 0.26); thus the margianl is usually longer than the postmarginal by approximately 0.06 mm. Abdominal petiole may be longer than or equal to the length of the hind coxae.

Types.—Listed under the five subspecies described below.

Hosts.—Bred from galls produced by *Diplolepis variabilis* (Bassett) and *D. bicolor* (Harris) on various wild rose species.

Range.—From Maine south to Massachusetts and westward to Illinois, Kansas and Utah. In other words, so far as known, this species seems to occur over the eastern two-thirds of the United States from Utah to the Atlantic coast.

Remarks.—The *calcarea* complex differs from the *discordans*, *acuta*, and *incerta* complexes in averaging considerably smaller in total length and this is shown also in the shorter abdomen, exposed tip of the dorsal valves (ninth abdominal segment), sixth abdominal segment, marginal and post-marginal veins. The most noticeable difference, however is in the reduced development of the female genitalia which average shorter in total length and in the reduced width of the expanded anterior plate of the ventral valves. The whole structure is not as dorsally produced or as strongly developed as the other complexes mentioned above. The different hosts also help to distinguish this complex.

In the general proportions and shape of the genitalia, however, it is closer to the *incerta* complex than to any of the other species from rose described in this paper.

E. calcarea superficially resembles *E. tylodermatis* but the two species can be distinguished on the basis of the following characteristics: In *calcarea* the carineae dorso-lateral to the top of the median furrow of the propodeum bend sharply ventrally and extend downward about one-third to one-fourth the length of the median furrow before they turn laterally (in *tylodermatis* the dip ventrally is much less); the wing veins of *calcerea* are heavier and brown in color rather than light straw yellow as in *tylodermatis;* the marginal vein in the former is broad and more heavily chitinized.

This species has been divided into six subspecies which are described below.

Eurytoma calcarea calcarea n. subsp.

Female.—Black. Length 2.5–4.5 mm. (aver. 3.5). Length of abdomen ranges from 1.7–2.5 mm. (aver. 2.2); segment 6 ranges from 0.55–0.75 mm. at widest point (aver. 0.64); width of segment is 29% of the length of the abdomen; last abdominal segment (exposed tip of dorsal valves) range in length from 0.15–0.32 mm. (aver. 0.22) thus it averages about 10% of the length of the abdomen. Internal genitalia range in length from 1.8–2.3 mm. (aver. 2.0); height from 1.0–1.3 mm. (aver. 1.1); dorsal and ventral valves turn dorsally, anteriorly at less than a right angle; the ventral valves extend above the dorsal valves and expand into a flat plate which averages 0.20 mm. at widest point (range 0.18–0.24); dorsal valves black, and uniformly thin for horizontal length. Thorax with the tegulae black. Propodeum most often with a very shallow wide median furrow; slightly wider at top than bottom and not demarcated laterally by distinct carineae; usually at top of furrow are two rectangular to square, shallow depressions whose surfaces appear shiny and smooth; rest of furrow below pits divided by fine irregular ridges which mark off shallow rectangular depressions; at base of median furrow is a deep rectangular pit; surfaces lateral to median furrow irregularly pitted and finely ridged except for a row of larger, 5- to 6-sided punctures across top margin; antennae with face of scape yellow for lower one-half, rest black to dark brown or whole scape dark brown to black; flagellum filiform, seven segmented, with the basal segment longer than wide; next 5 become progressively shorter until number 4 and 5 are square; number 6 is closely applied to number 7 but separated from it by a distinct annulation; 6 and 7 form a terminal unit that may be a slightly swollen club. Legs with the coxae black; black to dark-brown infuscation on all femurs; flares up from base of fore-femur and covers about one-half of face; mid-femur with slightly less infuscation than fore-femur; hind-femur completely covered except tips; fore and mid-tibiae with small smudge of black on outer face in most specimens; hind-tibiae with only tips brownish-yellow; parts of legs not black are brownish-yellow. Wing veins brownish-yellow to dark-brown; marginal vein stout and broad; stigmal club rectangular in shape; marginal ranges in length from 0.25–0.42 mm. (aver. 0.35); postmarginal ranges in length from 0.20–0.40 mm. (aver. 0.30); thus the two veins are most often subequal in length but in a few specimens both are equal; length of the marginal averages 1.17 times the length of the postmarginal.

Male.—Black. Length ranges from 1.7–3.2 mm. (aver. 2.5). Scape may be dark brown to black or lower one-half yellow, rest black; legs with black infuscation as in females; in a few specimens the fore-femurs and tibiae may be all yellowish-brown in which case the amount of black on the mid-legs may be reduced accordingly. Wing veins brown to dark-brown; postmarginal vein ranges in length from 0.22–0.35 mm. (aver. 0.28) and the marginal from 0.30–0.40 mm. (aver. 0.35); length of the marginal averages about 1.24 times the length of the postmarginal.

Types.—Topotypical, 150 females and 151 males, ***holotype*** female, ***allotype*** male and ***paratypes*** of both sexes in the Bugbee Collection. Paratypes of both sexes in the United States National Museum.

Type locality.—Wellsville, Utah. Galls collected on September 6, 1927; males and females emerged May 5 to 20, 1928. B. and H. Pack coll.

Host.—Reared from galls of *Diplolepis variabilis* (Bassett) and *Diplolepis bicolor* (Harris) on species of *Rosa*. Kinsey det.

Paratypes, not topotypical.—UTAH: Farmington, galls collected on September 12, 1927 and male and female parasites emerged on May 28 and June 10, 1928, Pack coll. from *Diplolepis variabilis* on *Rosa* species, Kinsey det., 20 females and 7 males; Chester, galls collected on August 22 and September 12, 1927, male and female parasites emerged on May 15–20 and June 1, 1928, B. & H. Pack coll., from *D. variabilis* and *D. bicolor* on *Rosa* species, Kinsey det., 12 females and 15 males; Provo, April 18, 1920, males and females emerged from *D. variabilis sculpta* on *Rosa* species, Kinsey coll., and det., 29 females and 12 males; Brigham, April 16, 1920, males and females emerged from *D. bicolor* var. on *Rosa* species, 9 females and 14 males.

Range.—The eastern half of Utah from its northern boundary southward to the central part of the state.

Remarks.—Emergence of this species begins in the latter part of April (earliest date April 20th) and continues into June (latest date June 20) with the bulk of the emergence coming in May.

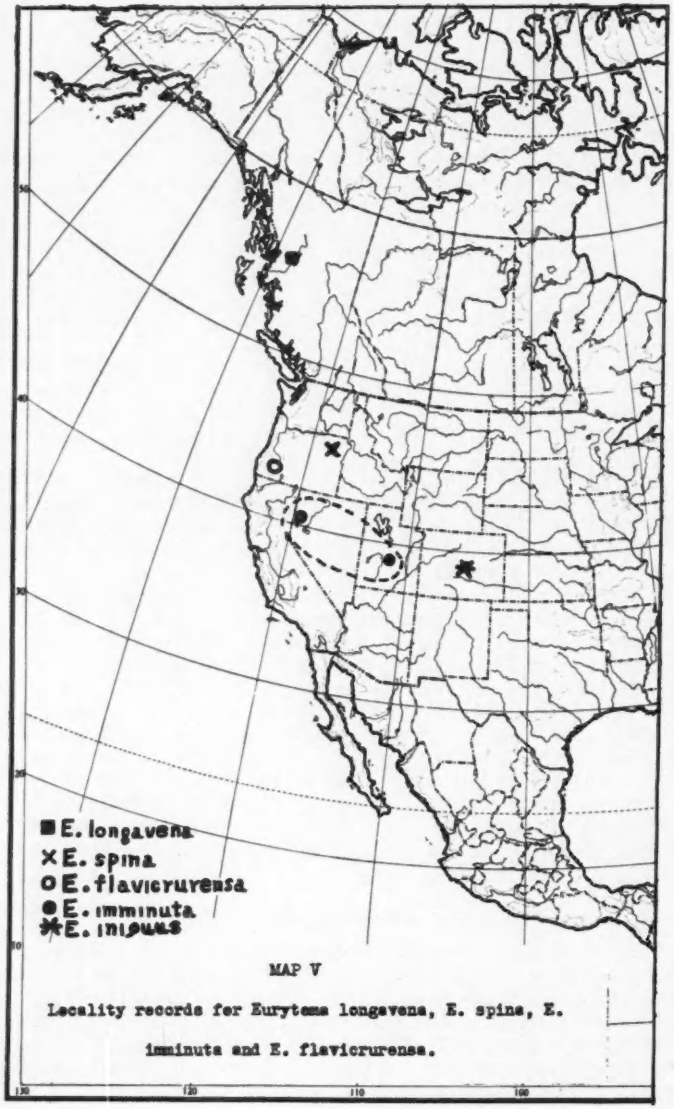
The exact host of this species within the gall is doubtful. Many of the galls on rose are subject to extensive infestation by inquilines, including *D. bicolor*, (Kinsey, 1922 and Kinsey and Ayres, 1922). In addition other parasites, representing several families of chalcids (*Callimomidae*, *Eulophidae*, etc.) are bred from these same galls. All that is certain, at the present time, is that the new species of *Eurytoma* issues from galls made by *D. variabilis* and *D. bicolor*, but whether it parasitizes the true gall maker, inquilines or other species of primary parasites of the gall maker is undetermined. The only clue that we have is the fact that *E. calcarea calcarea* emerges about the same time as the true gall makers. Kinsey (1922, p. 73) states that "the insects (*D. variabilis*) emerge early in the spring, in late April in the Rocky Mountain country, probably earlier or later in regions of earlier or later seasons."

The closest known relative of this subspecies is the next one, which occurs in western Nebraska. The two can be easily separated, however, on the basis of the descriptions. With more extensive collections from Colorado and other neighboring territory additional even more closely related subspecies should be found.

Eurytoma calcarea ignobilis n. subsp.

Female.—Length averages 3.7 mm. (range 3.0–4.3). Differs from typical *calcarea* in averaging slightly longer in total length; the longer ninth abdominal segment averaging 0.28 mm. (range 0.25–0.35); the more laterally compressed abdomen which in cross section has its greatest width in the upper third. Wing veins yellowish-brown; marginal vein moderately broad and heavy; marginal vein averages 0.38 mm. in length (range 0.30–0.40) and postmarginal averages 0.32 mm. (range 0.25–0.35). Other characteristics as in *E. calcarea*.

Male.—Length averages 2.5 mm. (range 2.2–2.9). Scape with the



MAP V

Locality records for Eurytoma longavena, E. spina, E. imminuta and E. flavicrurensa.

basal third yellow; rest brown to black. Otherwise very similar to males of *E. calcarea*.

Types.—Topotypical, 7 females and 2 males; *holotype* female and *allotype* male in Bugbee Collection. Paratypes in the United States National Museum.

Type locality.—Chadron, Nebraska. Galls collected on August 17, 1929; males and females emerged April 20, 1930, Kinsey coll.

Host.—Bred from galls of *Diplolepis bicolor*, on *Rosa* species, Kinsey det.

Range.—The locality is in the extreme northwestern corner of Nebraska. The subspecies probably will be found throughout Nebraska and South Dakota west of the one-hundredth meridian and east of the mountains in Wyoming.

Remarks.—*E. calcarea ignobilis* is related to *E. calcarea* from central Utah, as they are very similar in the color pattern of the scape and legs, propodeal configuration and female genitalia. They can be separated on the basis of the longer exposed end of the dorsal valves in this subspecies, and the broad or stout marginal vein.

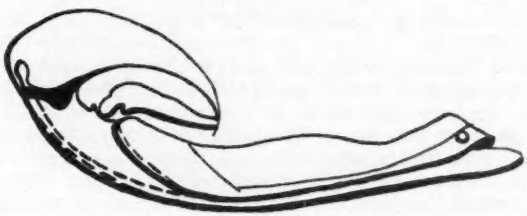


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FIG. 25. *Eurytoma terrea*, female genitalia. Enlarged to 150 mm.

In the propodeal features it also resembles some of the smaller specimens of *E. calcarea lucida* to the east from the neighborhood of Evanston, Illinois and thus forms a connecting link between the eastern and western populations of *E. calcarea*.

Eurytoma calcarea lucida n. subsp.

Female.—Average length 4.2 mm. (range 3.7–4.6). Differs from related subspecies of the *calcarea* complex in the yellowish-brown or yellow scape of the antennae; the yellowish-brown fore-legs and base of fore-coxae; the presence of brown infuscation on the mid and hind-legs, instead of black; the brownish-yellow wing veins with a stout or broad marginal vein; the relatively longer abdomen which averages 0.71 mm. (range 0.60–0.80) and the dark brown instead of black tegulae. The marginal vein averages 0.40 mm. in length (range 0.35–0.45) and the postmarginal averages 0.32 mm. (range 0.27–0.37). In some of the smaller specimens the propodeum may have a narrow and deep median

furrow delimited from lateral areas by distinct lateral carinae while in some larger specimens the median furrow may be wide and shallow and lack lateral carineae.

Males.—Males average in length 3.3 mm. (range 2.6–3.7). Differ from males of the other subspecies in scape and leg color much as the females. Among the males was one lone specimen in which the scape was totally black and black infuscation was present on all tibiae and femurs, and the petiole of the abdomen was the same length as the hind coxae.

Types.—Topotypical, 9 females and 5 males; ***holotype*** female and ***allotype*** male in the United States National Museum. Paratypes in the Bugbee Collection.

Type locality.—Evanston, Illinois. June 11, 1912, L. H. Weld coll.

Host.—Bred from galls on *Rosa* species of *Diplolepis bicolor*.

Range.—Known only from the one locality but it probably ranges through northern Illinois and Indiana and southern Wisconsin and Michigan.

Remarks.—The material from Evanston seems to have its closest affinities with the eastern *E. calcarea mimica* from the environs of Marshfield, Mass. However, populations which it will resemble more closely will eventually be found somewhere in northern Ohio, New York, and Pennsylvania.

The one odd male specimen mentioned in the description above may be a stray from a gall of another species and represent a different species of parasite. On the other hand, it conforms closely to the males of *E. calcarea infima* which occur in southern, Illinois. It is possible that the northern and southern populations may have a hybrid zone between them that is a result of past Pleistocene glacial history. If in glacial times the northern population was forced southward by the advancing ice cap, hybridization may have occured between the northern and southern populations. This is further suggested by the fact that some of the larger female specimens from the Evanston material show the wide, shallow propodeal median furrow characteristic of the southern subspecies. A hybrid zone between northern and southern populations is known for other species (see Kinsey, 1930: 57–59).

Eurytoma calcarea infima n. subsp.

Female.—Length averages 3.6 mm. (range 3.0–4.5). Differs from related subspecies of this complex in averaging slightly smaller. The legs show some black infuscation on the femurs and often on the tibiae. The tegulae are always black. The median furrow of the propodeum is set off from the lateral areas by distinct lateral carineae and the furrow is narrow with its widest portion just below the top; lateral carineae below widest portion approximately parallel and may diverge laterally at base of furrow; in some of the smaller specimens the lateral carineae are clear only in upper one-third to one-half so that the median furrow blends into the lateral areas below. Wing veins light yellow; marginal vein thin and averaging in length 0.38 mm. (range 0.27–0.45); postmarginal averaging 0.35 mm. (range 0.25–0.45); thus the two veins are most often subequal but may be equal in a few specimens.

Males.—Scape black. Black on all legs as in the female. Abdominal

petiole about same length as hind coxae. Wing veins brown and usually subequal as in the female.

Types.—Topotypical, 9 females and 1 male; ***holotype*** female, ***allotype*** male and ***paratypes*** in Bugbee Collection. Paratype females in the United States National Museum and the Museum of the Illinois Natural History Survey.

Type locality.—West Frankfort, Illinois. Galls collected in 1945 presumedly, but no actual date is given. Males and females emerged May 26–29 and June 3, 1946. S. Lienk Coll.

Host.—Bred from galls of ***Diplolepis bicolor*** on ***Rosa carolina***, S. Lienk det.

Range.—Known from only the one locality but it probably extends throughout southern Illinois and Indiana. Whether it has successfully crossed the Ohio river into Kentucky and the Mississippi river into Missouri can only be determined by more extensive collections.

Remarks.—This subspecies seems to be related to some of the populations of the succeeding species, ***E. calcarea mimica***, to the east, as well as to its more northern neighbor, ***E. calcarea lucida***, discussed in the preceding description.

Eurytoma calcarea mimica n. subsp.

Female.—Length averages 3.8 mm. (range 2.7–4.5). Infuscation on legs may be black or dark brown; often yellowish-brown tinge on front coxae. Tegulae black or dark brown. Scape of antennae usually all yellow to dark brown with upper tip often almost black. Propodeum varies in different populations from wide and shallow without median furrow, to median furrow with distinct lateral carineae; furrow, same width throughout its length. Wing veins yellow and marginal vein may be thin or mediumly stout; marginal averages 0.35 mm. in length (range 0.30–0.40); postmarginal averages 0.29 mm. (range 0.25–0.35); thus the two veins are usually subequal.

Males.—Average length 2.6 mm. (range 2.2–3.6). Legs black to dark brown on femurs and tibiae of all legs, or, front legs all yellowish-brown and brown to black infuscation on mid and hind legs only; in those with yellow fore-legs, coxae may show yellowish tinge. Scape with lower half yellow and upper half black to brown or whole scape may be dark brown to black. Petiole usually longer than hind-coxae. Wing veins yellow to yellowish-brown; marginal vein thin to mediumly stout and averages 0.30 mm. in length (range 0.25–0.35), postmarginal averages 0.24 mm. (range 0.20–0.32); thus the two are usually subequal.

Types.—Topotypical, 19 females and 13 males; ***holotype*** female, ***allotype*** male and ***paratypes*** in the United States National Museum. Paratypes in the Bugbee Collection.

Type locality.—Cambridge, Mass. Galls collected on July 18, 1909. Male and female parasites emerged on March 20, 1910. Timberlake coll. and det.

Host.—Bred from galls of ***Diplolepis bicolor*** on ***Rosa*** species.

Paratypes, not topotypical.—MASSACHUSETTS: Marshfield, June 21, 1919 on ***Rosa*** species; parasites emerged from galls on ***Diplolepis bicolor***, Kinsey det., 8 females and 2 males; Forest Hills, May 10, 1918 on ***Rosa*** species, parasites emerged from galls of ***D. bicolor***, Kinsey det.,

2 females and 5 males. MAINE: Orono, collected in 1890, parasite emerged from gall of *D. bicolor*, 1 female.

Range.—Along the east coast from Massachusetts northward to Maine.

Remarks.—This subspecies is quite variable and probably represents either several subspecies or a hybrid population. Large series from more northern and southern localities, which are lacking entirely for the present study, might help to clear up the status of these populations. For the present, the assumption that they represent a hybrid population, is favored as the situation seems to be parallel to the overlapping variation previously discussed for *E. calcarea infima* and *E. c. lucida*.

The present subspecies shows some populations that seem closest to *E. c. lucida* from northern Illinois, while other series show close affinities to *E. c. infima* from southern Illinois. Under the circumstances it seems best to lump all the material together as a single subspecies, especially since all the specimens come from a limited distributional area.

Eurytoma calcarea singularis n. subsp.

Female.—Differs from the other subspecies of the *calcarea* complex in average smaller length, 3.1 mm. (range 2.5–3.6); this smaller average size carries over into all the other measurements. Abdomen averages 1.7 mm. (range 1.4–2.0), the ninth abdominal segment averages 0.20 mm. (range 0.17–0.22), the marginal vein averages 0.28 mm. in length (range 0.22–0.32) and the postmarginal averages 0.26 mm. (range 0.20–0.30). Scape most often dark brown to black. Black infuscation on femurs and tibiae of all legs. Propodeum has a narrow median furrow that is widest at the top but narrows gradually, so that towards base it is one-half or less the width at top; furrow marked off from lateral areas by fine lateral carineae dorsally that may become indistinct about two-thirds of the way down; lateral areas uniformly minutely punctate except for row of large 5- to 6-sided punctures across upper margin. Wing veins light brownish yellow; marginal vein thin, not much wider than postmarginal; stigmal club small and rectangular in shape. Genitalia average 1.6 mm. in length, 1.0 mm. in height and the width of the expanded anterior plate of the ventral valves averages 0.17 mm.; dorsal valves thin and maintain same width for horizontal length, stylet arch in an oblique plane.

Males.—Average length 1.9 mm. (range 1.7–2.1). Wing veins dark-brown in color. Material insufficient for further description.

Types.—Topotypical, 6 females and 3 males; *holotype* females, *allotype* male and *paratypes* in Bugbee Collection. Paratypes in the United States National Museum.

Type locality.—Cambridge, Mass. Collected by J. Remington.

Host.—Labels read, emerged from pupa on August 23–28 and October 27–28, 1946, from gall on *Rosa* sp. Gall maker: *Diplolepis nebulosus* (Bass), L. H. Weld det.

Range.—Known only from the single locality but might be expected to occur wherever its host gall occurs.

Remarks.—This subspecies is the smallest of the complex of 6 subspecies described and might very well be considered a distinct species. In its genitalic characteristics however, it resembles very closely *E. c.*

mimica from the same locality but from a different host. Its smaller size, which is reflected in smaller averages for all measurements, as well as the different host distinguishes this subspecies from the others.

Eurytoma longavena n. sp.

Figs. 11, 12 and 13; Map V

Female.—Black. Length 3.5–4.1 mm. (aver. 3.7). Abdomen oval from the side, averages 1.9 mm. in length (range 1.7–2.1); plump with not much evidence of lateral compression; in cross section broadly oval with the greatest width near the middle; exposed ends of the dorsal and ventral valves level with the horizontal axis of the abdomen; abdomen ranges in depth from 0.90–1.2 mm. (aver. 1.0), and in width from 0.65–0.87 mm. depth is 1.4 times the width; sixth segment, from a lateral view, wide, averaging about 0.64 mm. (range 0.55–0.70); covers most of segment 7; width of segment 6 averaging about one-third length of abdomen; fine scaling on ventro-lateral aspect of segment 6 limited to lower one-third of surface, rest smooth and shiny black; exposed tips of the dorsal valves short and stubby, ranging in length from 0.15–0.22 mm. (aver. 0.18). Internal genitalia average 1.8 mm. in length, 1.1 mm. in height and dorsal and ventral valves turn dorsally at less than a right angle; ventral valves extend dorsally beyond dorsal valves but do not turn backwards upon themselves; stylet arch in an oblique plane; ventral valves, anteriorly, expand into a flat plate, which averages 0.22 mm. at widest point; dorsal valves maintain same width throughout horizontal length and are black in color. Thorax with the tegulae black. Propodeum with a broad, shallow median furrow that is widest at top and narrows ventrally; a distinct median ridge beginning at top of furrow; extends ventrally but becomes less distinct in lower quarter of furrow; ridges extending laterally, mark off on either side of median ridge, two large rectangular areas at top of furrow; succeeding lateral ridges mark off smaller rectangular areas, on either side of median ridge, which become progressively smaller ventrally; at base of furrow is a deep pit which may be divided into two foveae; areas lateral to median furrow covered with large 5- to 6-sided pits, dorsally, which become fine punctations ventrally; antennae with the scape dark brown to black or faint yellow tinge at basal end only; flagellum 7 segmented with the seventh segment made up of two closely fused segments; segment 1–5 somewhat moniliform in shape rather than sharply truncate on distal ends; all longer than wide; segment 6 closely applied to number 7 but not distinctly fused to it; flagellum same width throughout and ending in a blunt point; segment 7 about same length as segment 6. Legs with femurs black or very dark brown; tips yellow to brown; fore-tibiae with blackish smudge on middle outer face; mid and hind-tibiae black to dark brown, except yellow tips. Wing veins yellow to brown in color; stigmal club rectangular with flat to rounded base; marginal vein thin, ranges in length from 0.35–0.45 mm. (aver. 0.42); postmarginal vein ranges from 0.27–0.32 mm. (aver. 0.29); thus the marginal is 1.4 times the length of the postmarginal.

Males.—Averages about 3.0 mm. in length. Color of scape and legs as in the female.

Types.—Topotypical, 4 females and 3 males; ***holotype*** female,

allotype male and *paratypes* in Bugbee Collection. Paratypes in the United States National Museum.

Type locality.—Terrace, British Columbia. Galls collected in 1927 by W. Hippisley. No emergence date given.

Host.—Bred from galls of *Diplolepis bicolor* subspecies on a species of *Rosa*, Kinsey det.

Range.—*E. longavena* is recorded from only one locality, at the head of the Skeena channel, in north western British Columbia. It probably occurs along the foothills of the Coast mountains both north and south of Terrace.

Remarks.—This species can be differentiated from all other species of the genus bred from *Diplolepis* galls on *Rosa* because of the great width and reduced sculpturing of the sixth abdominal segment, the 6 segmented flagellum of the antennae, the fact that the antennae are longer than in other species and the unusually long marginal vein in relation to the length of the postmarginal vein. The sculpturing of the propodeum is also distinctive. Of the species of *Eurytoma* from rose the one that seems to have much in common with this species is *E. calcarea* from the eastern two-thirds of the United States, already described. It is possible that if there was adequate material from localities in between the two that *E. longavena* would be a subspecies of the *calcarea* complex, extending the range of the complex into western Canada. As it stands now the two are different enough to recognize them as distinct species on the basis of the characters mentioned above.

Eurytoma spina n. sp.

Map V

Female.—Differs from the subspecies of the *incerta* and *calcarea* complexes in being considerably smaller; average length 3.5 mm. (range 3.3–3.6); the abdomen averages 2.0 mm. in length; sixth abdominal segment 0.64 mm. and the exposed tips of the dorsal valves (ninth abdominal segment) averages 0.22 mm. in length or about 34% of the length of segment 6. Internal genitalia aver. 1.9 mm. in length, 0.92 mm. in height and the expanded dorsally projecting plate of the ventral valves averages 0.20 mm. in width; whole structure weakly developed; dorsal and ventral valves turn dorsally, anteriorly, at much less than a right angle (about 45°) so that the stylet arch is in almost a horizontal plane; ventral valves stout and wide for horizontal length. Scape of antennae usually black. Propodeum with a narrow but shallow median furrow. Wing veins yellowish-brown in color; marginal averages 0.35 mm. in length (range 0.32–0.37) and postmarginal averages 0.31 mm. (range 0.30–0.32).

Male.—Unknown.

Types.—Topotypical, 5 females; *holotype* female and *paratypes* in the United States National Museum. Paratypes in the Bugbee Collection.

Type locality.—La Grande, Oregon. Females emerged or collected on April 12, 1920.

Host.—Bred from *Diplolepis tuberculatrix versicolor* on *Rosa* species.

Range.—Northeastern Oregon.

Remarks.—This material is described as a distinct species because in

several characteristics it diverges from the *incerta* and *calcarea* complexes. This is especially evident in the weakly developed female genitalia. On the other hand, it may have some affinities among the *incerta* subspecies in that it occurs on a related host. It has even less in common with the *acuta* complex to the east. In still other characteristics, (size, length of the sixth abdominal segment and abdomen, and in the length and height relationships of the genitalia) it suggests some connections with *E. longavena* to the north in British Columbia. More collections from intermediate localities are needed to establish the relationships of *E. spina* with more certainty.

Eurytoma obtusilobae Ashmead

Ashmead, 1885, Trans Amer. Ent. Soc., Proc. 12: xii. Figs. 20, 21, and 23; Map IV.

Female.—Black. Length ranges from 2.9–4.3 mm. (aver. 3.7). Abdomen plump showing very little lateral compression; length averages 1.8 mm. (range 1.6–2.1); sixth abdominal segment, viewed from the side at its widest point, averages 0.59 mm. (range 0.50–0.65) or it is as wide or wider than segments 4 and 5 combined; exposed end of dorsal and ventral valves in line with horizontal axis of the abdomen; ninth segment short and blunt, averaging 0.13 mm. in length (range 0.10–0.17); thus the abdomen is about 13.8 times the length of segment 9. Internal genitalia weakly developed dorsally averaging 0.90 mm. in height (range 0.85–1.0); length averaging 1.8 mm. (range 1.6–2.0); dorsal valves about same width for horizontal length bending slightly dorsally, anteriorly, at less than a right angle; ventral valves turn dorsally, anteriorly, and expand into a flat plate averaging 0.16 mm. in width at widest point; stylet arch approaches a horizontal plane. Thorax with the tegulae yellowish-brown to dark brown; never black. Propodeum usually with a distinct, but shallow and narrow, median furrow marked off from lateral areas by slightly raised lateral carinae; furrow widest in upper one-quarter, rest about same width, or lateral carinae converge slightly at base; at top of furrow are two large rectangular convex areas separated by a fine ridge that becomes indistinct about one-quarter to one-third of the way down; convex areas may have smooth surfaces or may be crossed by slightly raised ridges at right angles to central ridge; at base of furrow is a rectangular shallow pit; lateral to top of the median furrow, carinae extend latero-ventrally and then bend dorso-laterally to demark semicircular areas whose ventral extension is not greater than one-quarter the length of the median furrow; area lateral to median furrow and below semicircular areas finely punctate except across top where a row of two or three large five to six sided punctures occur. Legs with the fore and mid-legs yellowish-brown; hind-legs with the femurs most often brown, less often black, medially; hind-tibiae may have slight brownish smudge on outer face; tips of hind-femurs and tibiae yellowish-brown. Scape and often the pedicle of antennae yellowish-brown; flagellum filiform and 7-segmented; segments 1–5 longer than wide and separated from preceding segments by a deep annulation; 6 is approximately square and separated from the 7 by a shallow but distinct annulation; seventh segment bluntly pointed and appears to consist of two closely fused segments. Wing veins lemon yellow to light brownish-yellow; marginal vein thin and stigmal long and narrow;

stigmal club small and often with a prominent elongate extension on its distal end that points toward the tip of the wing; marginal vein averaging 0.34 mm. in length (range 0.30–0.37) and the postmarginal averaging 0.27 mm. (range 0.22–0.35); thus the marginal is usually longer than the postmarginal.

Male.—Average length 2.9 mm. (range 1.9–3.6); color of scape, pedicle, antennae, and legs similar to the female. Wing veins yellow and proportion of veins as in the female. Marginal vein averaging 0.32 mm. (range 0.25–0.37) and postmarginal averaging 0.27 mm. (range 0.20–0.32) in length.

Types.—One female and 3 paratypes (2 females and 1 male). Redescription based on types and series of 5 females and 10 males from Vienna, Va., collected by J. C. Bridwell in May 1941. *Holotype* female, and *neotypes* of both sexes in the United States National Museum and Bugbee Collections.

Type locality.—Jacksonville, Florida. Ashmead coll.

Host.—From an "undetermined cynipid gall on *Quercus obtusiloba*." Neotype series recorded from *Diplolepis radicum* O. S. on *Rosa palustris*.

Additional localities.—VIRGINIA: King George, bred from gall of *Diplolepis radicum* from collection of L. H. Weld, 3 females and one male. NEW YORK: Medina, 1909, bred from galls of *D. radicum* O.S., from the collection of L. H. Weld; 2 females and 2 males. Mattituck, collected on September 9, 1923, from *D. radicum* on *Rosa carolina*, Roy Latham coll., 8 females and 3 males. MASSACHUSETTS: Gloucester, May 1930, from galls of *D. radicum* 4 females and 1 male. OREGON: La Grange (probably La Grande), April 12, 1920, from *Rosa* roots, *D. radicum* variety *plana*, 15 females. UTAH: Price, April 20, 1920, *D. radicum Utahensis*, Kinsey coll., 11 females. MINNESOTA: Eaglenest galls collected in September, 1944, females emerged on July 16, 1945, Balduf coll., from a "large corky" gall on stem of *Rosa* sp., S. Lienk. det. 3 females. CANADA: Aweme, MANITOBA, May 19, and 22, 1905, N. Criddle, from rose gall on ground, 5 females. ILLINOIS: Glencoe, May 17, (no year given), bred from *D. utahensis* Bass, No. 55 from collection of L. H. Weld, 2 females and 2 males.

Range.—The range of this species appears to be all of North America although specific locality records are lacking for the middle west, the southern tier of states except Florida, the Pacific coast and much of Canada. This is an unusually extensive range but the material studied from the widely scattered localities is enough alike in the characteristics presented to include them all in the same species.

Remarks.—Some indications of subspeciation are seen in the slightly larger average size (3.9 mm.) of the western material from Price, Utah and La Grande, Oregon as well as their longer abdomen (aver. 1.9 mm.) and deeper median furrow of the propodeum. More material from many intermediate localities will be needed before subspecies and their ranges can be clearly determined.

The yellow tegulae, legs, scape and pedicle as well as the short, stubby exposed end of the dorsal valves, and the weakly developed genitalia of the females easily distinguishes this species from all the other species bred from rose galls. It does not seem to be closely related to any of the other species of *Eurytoma* from rose galls.

Ashmead might possibly have erred in the host designation as the species has not been recorded in the literature since he described it in 1885. Such a supposition is suggested also by the fact that all the material in my collection as well as in the United States National Museum was bred from galls of *Diplolepis radicum* on rose. It would not be surprising to find that the "undetermined cynipid gall" of Ashmead is either an error in determination of the host gall or that he identified the parasite with the wrong gall.

Eurytoma iniquus n. sp.

Map V

Female.—Black. Length averaging 3.2 mm. (range 2.8–3.3). Abdomen plump; slight lateral compression; averaging 1.7 mm. in length (range 1.6–1.8); sculpturing limited to lower half of sixth segment; recedes towards anterior margin of segment dorsally; segment 6 at widest point averaging 0.45 mm. (range 0.40–0.50); abdomen not dorsally produced anteriorly; ninth segment short and broad, averaging 0.15 mm. in length (range 0.12–0.17); spiracle of ninth oval in outline. Internal genitalia with dorsal and ventral valves turning dorsally, anteriorly at almost a right angle; dorsal valves thin for horizontal length; stylet arch in a verticle plane; length of genitalia averaging 1.4 mm.; height 1.0 mm. and expanded anterior plate of ventral valves averaging 0.17 mm. at widest point. Thorax with the tegulae black to dark brown. Propodeum with a shallow median furrow; widest at top becoming narrow ventrally; lateral carinae separating furrow from lateral areas very faint dorsally becoming indistinct ventrally; lateral areas finely rugose; shallow rectangular pit at base of propodeum. Scape of antennae most often yellow; may be some black infuscation on upper tip in a few specimens. Legs with the inner faces of the fore-coxae, femurs, tibiae, and mid-femurs and tibia, yellow; rest of fore, mid, and hind-coxae black; hind-femurs and tibiae with brown infuscation medially. Wing veins brown; marginal vein stout; about twice the width of the postmarginal vein which tapers to a fine point; stigmal club small and rounded basally; marginal vein averaging 0.36 mm. in length (range 0.35–0.37) and postmarginal averaging 0.27 mm. (range 0.22–0.30); thus the marginal is always longer than the postmarginal by 0.09 mm. on the average or the marginal is 1.33 times the length of the postmarginal.

Male.—Average length 2.6 mm. (range 2.3–3.0). Tegulae black or dark brown. Scape of antennae black except yellow base. Legs with black infuscation on all femurs and tibiae. Wing veins brown; marginal broad and averaging 0.37 mm.; postmarginal averaging 0.28 mm. in length.

Types.—Topotypical, 9 females and 2 males; *holotype* female, *allotype* male, and *paratypes* in the United States National Museum. Paratypes in the Bugbee Collection.

Type locality.—Manitou, Colorado. Collected April 24, 1920.

Host.—*Diplolepis neglectus* (= *D. tuberculatrix*) on *Rosa.*

Range.—Known only from the one locality just west of Colorado Springs, Colorado. Probably extends, however, both north and south from Manitou along the eastern slopes of the Central Rockies.

Remarks.—*E. iniquus* appears to be closer to *E. flavicrurensa* from Ashland Oregon and *E. spongiosa* than to anything else in the material studied so far. It is separated from *E. flavicrurensa* by two extensive mountain ranges and much arid land so that any relationship to *E. flavicrurensa* must be very distant. It is much more likely that closer relatives will be found in neighboring territory to the north or south when more material is available.

E. spongiosa occurs in the same neighborhood but *iniquus* is different enough from any of the populations of *spongiosa* to set it apart as a distinct species.

It may be distinguished from the species mentioned above by the yellow fore and mid-legs and scape, the greater difference in the length of the postmarginal vein in comparison with the length of the marginal vein and the anterior, dorsal development of the genitalia.

Eurytoma spongiosa n. sp.

Figs. 14, 15 and 16; Map III

Female.—Black. Length 2.0–4.0 mm. (aver. 3.3). Abdomen oval in lateral view, plump and with little evidence of lateral compression; averaging in length 1.8 mm. (range 1.2–2.3); dorsal valves (last abdominal segment) and exposed ends of ventral valves level with the horizontal axis of abdomen; segment 6 averaging in width at widest point 0.50 mm. (range 0.32–0.62) or approximately 26% of the length of the abdomen; segment 9 short and stubby, averaging in length 0.15 mm. (range 0.10–0.22); thus the abdomen is about 12 times the length of segment 9. Internal genitalia most often only weakly developed, with usually broad and stout dorsal valves, lack of pronounced dorsal development of the valves, anteriorly, and the stylet arch in a horizontal to oblique plane; dorsal valves mostly black for horizontal length and they bend dorsally, anteriorly, at less than a 45° angle; ventral valves dorsally expand into a narrow flat brown plate which average 0.16 mm. at its widest point (range 0.12–0.25); length of genitalia averaging 1.6 mm. (range 1.3–2.1) and height averaging 0.89 mm. (range 0.67–1.3); in some or the larger specimens dorsal valves may be narrow for horizontal length and turn more abruptly dorsally, anteriorly; in such cases, ventral valves are produced more dorsally so that the stylet arch is in an oblique plane. Tegulae black. Propodeum with a shallow to deep, narrow, median furrow that is widest at top and narrows gradually ventrally; lateral carineae demark furrow from lateral areas which are most often finely punctate except across top where there may be two or three large, deep 5- to 6-sided pits; lateral to median furrow are large circular areas, demarked by carineae that dip ventrally about a third of the length of furrow and then extend dorso-laterally. Legs most often with the fore and mid-legs yellowish-brown and the hind-legs with black or dark brown on femurs and tibiae; tips yellowish-brown; less often legs may show varying amounts of black or dark brown infuscation on all femurs and tibiae; antennae short and stocky with the scape most often yellowish-brown; less often black to dark brown; flagellum filiform, seven segmented with the first segment longer than wide and the rest becoming successively shorter until segments 5 and 6 are approximately square; segment 7 consists of two very closely fused units and segment

6 is separated from segment 7 by a distinct annulation rather than a peduncle as in the preceding segments. Wing veins light yellowish-brown; marginal vein thin or narrow to mediumly broad; stigmal club small, often narrowly rectangular with bottom margin rounded; marginal vein averages 0.35 mm. in length (range 0.30–0.42) and postmarginal vein averages 0.28 mm. (range 0.22–0.37); thus the marginal averages about 1.2 times the length of the postmarginal.

Male.—Average length 2.6 mm. (range 2.0–3.4). Scape varies from yellow to black or dark brown on outer face. Legs often with black or dark brown infuscation on all femurs and tibiae, increasing in amount from front to rear; rest of legs brownish-yellow; less often fore and mid-legs or just fore-tibiae all brownish-yellow and black to brown infuscation on hind-legs only. Color of wing veins and length relationships of marginal and postmarginal as in the female.

Types.—Topotypical, 44 females and 16 males; ***holotype*** female, ***allotype*** male, and ***paratypes*** of both sexes in Bugbee Collection. Paratypes in the United States National Museum.

Type locality.—Bloomington, Indiana. Galls collected from November through April, 1932–35, males and females emerged in May and June 1933–1935, Bugbee coll.

Paratypes, not topotypical.—MASS. Northampton: males and females emerged on May 18, 1918, H. M. Parshley coll.; bred from galls of ***Diplolepis rosae;*** 5 females and 5 males. Sharon, females emerged on May 26, 1919. A. C. Kinsey coll.; bred from galls of *D. rosae*, 2 females. Cohasset, male emerged on May 6 (year not given), from Wooly rose gall, *D. rosae*, 1 male. Forest Hills, male and female emerged on June 10, 1918, from *D. dichlocerus*. Kinsey det. and coll., 15 females and 1 male; OHIO: Buckeye Lake, galls collected Sept. 21, 1921, from galls of *D. dichlocerus*, Huber det., 1 female and 2 males; MARYLAND: Bethesda, males emerged May 18 and 19, 1914, bred from sweet brier, M. M. Lungstedt coll., *D. dichlocerus*, 1 male. RHODE ISLAND: Providence, cut from gall of *D. rosae*, Thompson coll. 3 females and 2 males. NEW YORK: Bemus Point, galls of *D. dichlocerus* only from which no parasites were bred, collected in the fall of 1947; another series of galls collected on November 30, 1946 and April 8, 1947, males and females emerged May 5 to June 26, 1947, from galls of *D. rosae* on Rosa species, Bugbee coll. and det., 18 females and 22 males; Burdett, from galls of *D. rosae*, L. H. Weld coll., 8 females and 7 males. COLORADO: Boulder, from gall of *D. rosae*, Cockerell coll. 29 females and 7 males. ARKANSAS: Farmington, galls collected on September 8, 1925 by R. W. Shreve, *D. dichlocerus* variety on *Rosa rubiginosa*, 93 females and 37 males. PENNSYLVANIA: Meadville, galls collected on November 11, 1947, parasites emerged on April 4 and May 8, 1948, from *D. dichlocerus*, Bugbee coll. and det. 5 females; INDIANA: Bloomington, galls collected on March 3, 1935 and April 14, 1934, adults emerged May 23-June 6, 1935 and June 2, 1934 from *D. dichlocerus*, Bugbee det. and coll., 10 females and 1 male. VIRGINIA: Vienna, adults emerged on May 23–30 and June 6, 1911, R. A. Cushman coll., from *D. dichlocerus*, Quaintance No. 7045, 10 females and 6 males; ILLINOIS: Evanston, males and females emerged June 28, 1909 from galls of *D. dichlocerus*, 4, from collection of L. H. Weld, 4 females and 8 males. MICHIGAN: Grand Rapids, galls

collected on October 25, 1928, males and females emerged June 1, 1929, from galls of *D. tuberculatrix*, Kinsey det., on *Rosa*. Benner coll., 10 females and 5 males; Cheboygan, galls collected on October 3, 1927, males and females emerged May 30, 1928, from galls of *D. tuberculatrix*, Kinsey det., on *Rosa*, Kinsey coll., 1 female and 2 males. UTAH: Manti, galls collected on September 23, 1927, males and females emerged on May 20, 1928, from galls of *D. tuberculatrix*, Kinsey det. on Rosa, H. J. Pack coll., 1 female and 2 males; Cedar City, galls collected on September 5, 1929, males and females emerged on May 1, 1930, Kinsey det., on *Rosa* Kinsey coll., 2 females and 1 male; Wellsville, galls collected on September 5, 1927, females emerged on May 24, 1928, from galls of *D. xerophila*, Kinsey det., on *Rosa* B. and H. Pack coll., 11 females; Provo, April 4, 1920, from galls of *D. tuberculatrix xerophila*, 25 females and 6 males. Green River, collected on April 21, 1920, from galls of *D. tuberculatrix* var. *xerophila* on *Rosa*, 10 females and 4 males. Logan, collected May 1, 1933, bred from Rose gall by W. L. Thomas coll.; Price, collected on April 20, 1920. from *D. tuberculatrix* on *Rosa;* IOWA: Sioux City, No. 261, from rose galls, C. N. Ainslie coll. 4 females and 2 males. CANADA: SASKATCHEWAN; Oxbow, May 15, 1907, from rose gall, F. Knab coll.

Host.—Bred from galls of *Diplolepis rosae* (Linneaus) on *Rosa* species Kinsey det. Additional hosts include *Diplolepis dichlocerus* (Harris) and *D. tuberculatrix* (Cockerell) on *Rosa* species.

Range.—This species apparently ranges wherever its hosts occur, which is most if not all of North America, east of the Sierra Nevada mountains.

Emergence.—May 1 to June 28.

Remarks.—*E. spongiosa* is a wide ranging, highly variable species. If a detailed study of large series from a morphological, cytological and physiological standpoint could be made a more certain light might be thrown on its evolutionary history and its phylogenetic affinities. There are indications that it is a continental species in the process of breaking up into smaller subspecific populations. Its host galls may occur on the same or neighboring rose bushes. *D. rosae* and *D. dichlocerus* galls have been collected often on the same bush. The multiple hosts of this species, its wide range, the narrow sixth abdominal segment and the weakly developed female genitalia suggest that it is one of the most primitive of the rose gall parasites of the genus *Eurytoma*.

This species appears to be most closely related to *E. curvavena*. This is suggested in the similar size, length of the dorsal valves (ninth abdominal segment), color of the legs, length of the marginal and postmarginal veins and the weak development of the female genitalia.

All of the species of parasites treated in this paper were compared with a specimen in the United States National Museum of *E. rosae* Nees, determined by G. Mayr from Central Europe. None of them resembled even closely *E. rosae*. With all of the rose cuttings that have entered this country from Europe, has come one common rose gall maker (*Diplolepis* rosae). It has become well established and widely disseminated over most of the United States, but *E. rosae* does not seem to have been introduced with it. *E. spongiosa* is a primary parasite of *D. rosae* in the United States while *E. rosae* has been shown to be an external

parasite of an inquiline (*Periclistus brandtii*) which occurs in the galls of *D. rosae* in Europe (Blair, 1945). Thus the two species (*E. spongiosa* in the U. S. and *E. rosae* in Europe) have quite different relationships within the galls. In addition *E. rosae* is listed from numerous other hosts which include *Hymenoptera, Lepidoptera, Diptera* and *Coleoptera*. Because of a very unusual wing vein condition that occurs in some of the material from a single locality in northeastern Minnesota the following material is described as a distinct subspecies of *E. spongiosa*.

Eurytoma spongiosa curvavena n. subsp.

Figs. 17, 18 and 19; Map III

Female.—Differs from typical *spongiosa* as follows: Length 2.2–3.5 mm. (aver. 3.1); ninth segment short and blunt, averaging 0.13 mm. (range 0.07–0.17) in length. Internal genitalia average 1.5 mm. (range 1.3–1.7) in length and height average 0.69 mm. (range 0.67–0.70); stylet arch in a horizontal plane. Propodeum with a variable median furrow that is most often narrow and clearly marked off from lateral areas by lateral carinae; usually wider at top than bottom although lateral carinae may be approximately parallel from top to bottom; shallow rectangular pit at base of furrow; antennae with the scape either all yellowish-brown or upper tip black only; flagellum weakly clavate; first and second joints longer than wide, rest approximately square; last three segments fused closely together forming a slightly swollen club; flagellum thus apparently only 6 segmented. Wing veins yellowish-brown to dark brown; marginal thinly rectangular and not heavily chitinized; postmarginal most often straight but may be sharply bent upwards forming a semi-circle; marginal averaging 0.33 mm. (range 0.30–0.40); curved postmarginal averaging 0.40 mm. (range 0.37–0.42) and straight postmarginal averaging 0.29 mm. (range 0.25–0.32); thus in specimens with the curved postmarginal, this vein is usually longer than the marginal while in those with a straight postmarginal it is usually shorter than marginal.

Male.—Length averaging 2.6 mm. (range 2.5–3.2). Scape of antennae black except lower third or less. Legs variable as in female; some with fore and mid-legs all yellowish-brown or with brown smudge on outer face of mid-tibiae only; others with black on all legs as in female. Wing veins dark brown; marginal stouter than in female and more heavily chitinized; marginal averaging 0.35 mm. (range 0.30–0.37) and postmarginal averaging 0.29 mm. (range 0.25–0.37); specimens with curved postmarginal with vein relationships as in the female.

Types.—Topotypical, 24 females and 22 males; *holotype* female, *allotype* male, and paratypes of both sexes in Bugbee Collection. Paratypes of both sexes in the United States National Museum and the Museum of the Illinois Natural History Survey.

Type locality.—Eaglenest, Minnesota. Galls collected in September 1944, males and females emerged on July 17, 1945, W. V. Balduf coll.

Host.—From bristly gall on stem (probably *Diplolepis multispinosa*) on *Rosa* species, S. Lienk det.

Range.—Northeastern Minnesota.

Remarks.—This subspecies can be differentiated by the six-segmented and weakly clavate flagellum, the deep, narrow median furrow of the

propodeum with approximately parallel sides and the occurence of the startingly different shape of the postmarginal vein in some specimens. This latter feature departs widely from the usually straight postmarginal vein, characteristic of the genus *Eurytoma*.

An analysis of the 49 specimens in the series from Eaglenest, Minn. gives 20 males and 20 females with the normal straight postmarginal vein and 3 males and 6 females with the bent vein or 18.3+% of the total. The numbers are too small to draw positive conclusions but it does seem warranted to say that the bent postmarginal is probably a mutation from the normal straight condition of the vein.

Correlated with the bent postmarginal is a reversal in the relationship of the length of the marginal and postmarginal veins. Instead of the usual condition where the marginal averages longer than the postmarginal the postmarginal averages longer than the marginal.

One male specimen exhibiting the bent wing vein also has abnormal antennae. In this specimen there is one less petiolate segment in the flagellum but the terminal unit appears to be composed of three fused segments instead of the characteristic two. Thus the flagellum is only five segmented instead of six as in the normal male antennae.

E. curvavena seems to approach most closely to *E. spongiosa*, and their similarities and differences are given in more detail under the description of the latter.

Eurytoma flavicrurensa n. sp.

Map V

Female.—Average length 3.5 mm. (range 3.3–3.6). Abdomen plump with only slight lateral compression; averaging 1.9 mm. (range 1.8–1.9) in length; ninth abdominal segment short and broad, averaging 0.19 mm. (range 0.17–0.20) in length; and on a level with horizontal axis of abdomen; fine scaling on lateral face of sixth segment limited to lower half; dorsal surface smooth and shiny; sixth averaging at widest point 0.51 mm. (range 0.47–0.57); thus it averages about 26% of the length of the abdomen or the abdomen is 3.7 times as long as segment 6. Internal genitalia well developed, the dorsal and ventral valves turning dorsally, anteriorly at approximately a right angle; dorsal valves black for horizontal length and narrow; total length of genitalia averaging 1.6 mm. height 1.1 mm. and expanded plate of ventral valves averaging 0.17 mm. at widest point; stylet arch near a vertical plane. Tegulae dark brown to black; propodeum with a shallow median furrow that is widest at top and narrows ventrally; marked off from lateral areas by irregular lateral carineae; ridge down central part of furrow becomes indistinct ventrally; lateral areas finely punctate. Scape of antennae yellow. Legs with the fore and mid-coxae, femurs and tibiae of legs yellow to yellowish-brown. Wing veins light brown to brown; marginal mediumly stout and averaging 0.37 mm. in length; postmarginal vein averaging 0.30 mm. in length.

Males.—Unknown.

Types.—Topotypical, 5 females; *holotype* female and *paratypes* in the United States National Museum. Paratype female in the Bugbee Collection.

Type locality.—Ashland, Oregon. April 6, 1920.

Host.—Bred from galls of *Diplolepis politus* var. on *Rosa.*

Range.—Known only from the single locality in the southwestern corner of Oregon.

Remarks.—*E. flavicrurensa* differs from other eurytomid species from rose galls in the yellow fore and mid-coxae, the lack of any black infuscation on the femurs or tibiae of any of the legs, and the narrow dorsal valves of the genitalia, which along with the ventral valves, turn dorsally, anteriorly, at approximately a right angle.

Its closest affinities seem to be with *E. spongiosa.* This is shown in its relatively small size, length and shape of the dorsal valves, length of the abdomen, sixth abdominal segment and marginal and postmarginal veins.

E. flavicrurensa may represent the extreme western equivalent of *E. spongiosa* but more material is needed before its true status can be fully determined.

Eurytoma imminuta n. sp.

Figs. 23 and 24; Map V

Female.—Mostly black. Length 2.2–3.6 mm. (aver. 3.0). Abdomen circular in outline from the side, and very plump; width 0.75–0.88 mm. (aver. 0.79); depth 1.0–1.2 mm. (aver. 1.1), thus the depth is 1.38 times the width; length of abdomen 1.5–1.6 mm. (aver. 1.5); tips of the dorsal and ventral valves in line with the horizontal axis of the abdomen; dorsal valves (ninth abdominal segment) extremely short and stubby; length 0.07–0.12 mm. (aver. 0.10); segment 6 not much wider from a dorsal view than segment 5; ranges in width, as seen from the side, 0.32–0.40 mm. (aver. 0.38); thus width of segment 6 averages about 25% of the length of the abdomen; fine scaling on lateral aspect of segment 6 pronounced basilly but does not reach posterior border of segment; covers about lower half of surface. Internal genitalia small and only weakly developed dorsally; averaging 1.3 mm. (range 1.2–1.5) in length and about 0.71 mm. (range 0.70–0.72) in height; dorsal extension of the dorsal and ventral valves slight and they turn dorsally at considerably less than a right angle; ventral valves expand into a narrow plate which averages 0.12 mm. in greatest width; stylet arch in a horizontal plane. Thorax with the tegulae black. Propodeum with a narrow and deep median furrow that maintains about same width for whole length (*i.e.*, lateral carinae marking sides of furrow remain parallel); two oval areas with smooth shiny surfaces at top of furrow are indistinctly divided by a median ridge; rest of surface of furrow divided into irregular rectangles by transverse ridges; areas lateral to median furrow finely pitted except across top where a row of larger 5- to 6-sided pits occur, slanting ventrally; at base of furrow is a cresent shaped pit. Antennae with the scape yellow to yellowish-brown; flagellum 6 segmented and weakly clavate; first segment longer than wide; the succeeding segments become shorter until the fourth and fifth are almost square, or as long as wide; the terminal segment consists of three closely fused slightly swollen segments; segments sharply truncate distally. Legs with the fore-legs yellowish-brown or with a tinge of black at base of fore-femurs only; mid-legs may be yellowish-brown or with slight blackish tinge on outer medial face of mid-tibiae; hind-legs with the

femurs black to dark brown except tips which are yellow; hind-tibiae with black to dark brown medially shading to yellow or yellowish brown at tips. Wing veins yellow to yellowish-brown; stigmal club deeply rounded basilly; length of marginal vein 0.30–0.35 mm. (aver. 0.32); postmarginal vein 0.25–0.32 mm. (aver. 0.27) thus the marginal is 1.18 times the length of the postmarginal.

Male.—Average length 2.4 mm. (range 1.6–2.8). Front and mid-legs all yellow; hind-legs with some infuscation on hind femur and slight amount on tibiae. Scape half yellow and half black. The material is insufficient for further description.

Types.—Topotypical, 9 females and 1 male; ***holotype*** female, ***allotype*** male, and ***paratypes*** in Bugbee Collection. Paratypes in the United States National Museum.

Type locality.—Pyramid Lake, Nevada. Galls collected on October 3. 1928 by E. W. Erlanson. Males and females emerged on May 20, 1929.

Host.—Bred from galls on ***Rosa puberulenta***, Erlanson det. made by ***Diplolepis variabilis*** var. Kinsey det.

Range.—Central Utah, west to northwestern Nevada. Occurs along the foothills of the isolated mountain ranges typical of the arid semi-desert region of the Great Basin area.

Paratypes, not topotypical.—UTAH: Chester, galls collected on August 22, 1927, males and females emerged July 5, 1928, from galls of *D. variabilis* Kinsey det., on *Rosa* B. and H. Pack coll., 12 females and 4 males.

Remarks.—This species differs from all others on rose in its extremely short dorsal valves, weak development of the internal genitalia, circular abdomen, reduced width of segment 6 and the sculpturing of the propodeum. This species is most closely related to *E. spongiosa* but they can be easily separated by the characters itemized above. It resembles *spongiosa* in its six segmented, weakly clavate antennae and in most of its average measurements of various parts. The genitalic relationships and the width of the 6th abdominal segment are exceptions. The different host species favors considering the material a distinct species also.

LITERATURE CITED

1. **Ashmead, W. H.** 1885. Studies in North American Chalcididae, with descriptions of new species from Florida. Trans. Amer. Ent. Soc., Proc. 12: XI-XIX.
2. **Beutenmuller, W.** 1892. Catalogue of gall-producing insects found within fifty miles of New York City, with descriptions of their galls, and some new species. Bull. Amer. Mus. Nat. Hist. 4: 245–278.
3. **Blair, K. G.** 1945. Notes on the economy of the rose galls formed by Rhodites (Hymenoptera, Cynipidae). Proc. Roy. Ent. Soc. London, Ser. A 20(1–3): 26–31.
4. **Bugbee, R. E.** 1936. Phylogeny of some eurytomid genera. Ent. Amer. n. s. 16(3): 169–223.
5. ———. 1941a. Five new species of *Eurytoma* from Mexico. (Eurytomidae, Hymen.). Ann. Ent. Soc. Amer. 34(2): 377–388.
6. ———. 1941b. Six new species of the genus *Eurytoma* from Mexico (Hym.), Part II. *Atrateges* Group. Rev. de Ent. 12(3): 493–506.
7. ———. 1944a. Two new species of the *Laxitas* complex from Mexico. (Hymenoptera, Eurytomidae). Jour. Kansas Ent. Soc. 17(1): 23–29.

8. ———. 1944b. Eleven new species of *Eurytoma* from Mexico. (Eurytomidae: Hymen.). Parts III and IV. *Breviura* and *Aureata* groups. Ann. Ent. Soc. Amer. 37(4): 420–438.
9. ——— 1945. Eight new species of the genus *Eurytoma* from Mexico and Guatemala (Hym. Eurytomidae). Parts V and VI. *Quadrata* and *Corpulenta* groups. Ann. Ent. Soc. Amer. 38(1): 53–69.
10. **Dobzhansky, Th.** 1947. Adaptive changes induced by natural selection in wild populations of *Drosophila*. Evol. 1 (1–2): 1–16.
11. **Felt, E. P.** 1940. Plant galls and gall makers. Comstock Publ. Co., Ithaca, New York. 1–364.
12. **Fullaway, D. T.** 1912. Gall-fly parasites from California. Jour. New York Ent. Soc. 20(4): 274–281.
13. **Gahan, A. B.** 1918. A synopsis of the species belonging to the chalcidoid genus *Rileya* Ashmead (Hymenoptera). Proc. Ent. Soc. Washington 20: 136–150.
14. **Kinsey, A. C.** 1922. Studies of some new and described Cynipidae (Hymenoptera). Indiana Univ. Studies 9(53): 1–141.
15. ——— and **Ayres, K. D.** 1922. Varieties of a rose gall wasp (Cynipidae, Hymenoptera). Indiana Univ. Studies 9(53): 142–171.
16. **Kloet, G. S.,** and **Hincks, W. D.** 1945. A check list of British insects. T. Buncle and Co., Ltd., Arbroath, England. Pp. 1–483.
17. **Noble, N. S.** 1939. A new species of chalcid (Genus Eurytoma) associated with *Tepperella trilineata* Cam., a wasp causing galling of the flower buds of *Acacia decurrens*. Proc. Linnaean Soc. New South Wales 64(3–4): 225–241.
18. **Phillips, W. J.** 1927. *Eurytoma parva* (Girault) Phillips and its biology as a parasite of the wheat joint worm, *Harmolita tritici* (Fitch). Jour. Agric. Res. 34: 743–758.
19. ———. 1936. A second revision of the chalcid flies of the genus *Harmolita* (*Isosoma*) of America north of Mexico, with descriptions of 20 new species. U. S. Dept. Agric. Tech. Bull. No. 518, pp. 1–25.
20. ——— and **Emery, W. T.** 1919. A revision of the chalcid-flies of the genus *Harmolita* of America north of Mexico. Proc. U. S. Nat. Mus. 55: 433–471.
21. **Rohwer, S. A.,** and **Fagan, M. M.** 1917. The type-species of the genera of the Cynipidea, or the gall wasps and parasitic cynipoids. Proc. U. S. Nat. Mus. 53: 357–380.
22. **Triggerson, C. J.** 1914. A study of *Dryophanta erinacei* (Mayr) and its gall. Ann. Ent. Soc. Amer. 7: 1–46.
23. **Viereck, H. L.** 1916. Hymenoptera of Connecticut. State Geol. Nat. Hist. Survey Bull. 22. Hartford, Conn. 1–823.
24. **Walsh, B. D.** 1870. On the group Eurytomides of the Hymenopterous family Chalcididae. Amer. Ent. and Bot. 2(10): 297–301.

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Four publications are announced: the Bulletin; the O.S.R. News; the O.S.R. Publications; and the Yearbook. Six bulletins and 16 O.S.R. Publications (one of which was apparently withdrawn) have been published so far. Most titles are in English, and it is specifically announced that the O.S.R. News is now being published in English. The O.S.R. Publications include "articles of such a length, that cost of publication would be prohibitive to scientific journals; or also articles of a very special nature, which are however of a scientific value." Four of these are of entomological interest: "A note on the larrid wasps, *Dilara schlegelii* (Rits.) and *Hyloliris mandibularis* Will. (Hym., Sphecoidea)," by J. van der Vecht, O.S.R. Pub. 13; "Insects on Canna, observations in a town garden," by L. G. E. Kalshoven, O.S.R. Pub. 14; "On the distribution of *Delias crithoe* (Boisd.) in Java (Lep., Pieridae)," by L. J. Toxopeus, O.S.R. Pub. 15; and "Remarks on the genus *Musca* L. (s.l.) and its medical importance in Indonesia," by H. A. Bakker, O.S.R. Pub. 16.—M. T. J.

TWO NEW SPECIES OF TROMBICULINDUS RADFORD FROM NORTH BURMA

(Acarina: Trombiculidae)[1]

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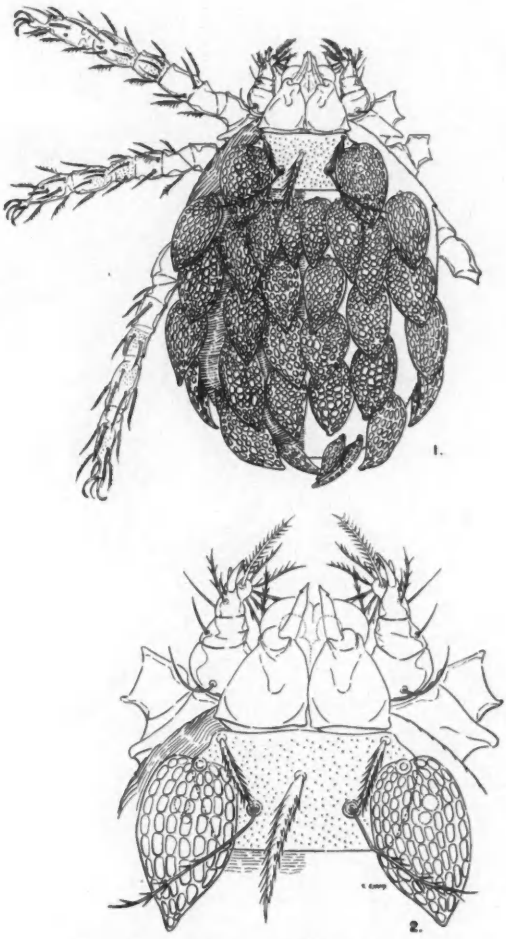
During the investigations on the epidemiology of scrub typhus in North Burma during the recent war, the United States of America Typhus Commission collected many interesting species of trombiculid mites. Perhaps the most remarkable of these are two species in which the dorsum is covered by bristles which have become modified to form very broad foliate scales. The posterolateral setae of the scutum are similarly modified. This condition is unknown in the family Trombiculidae except in the monotypic genus *Trombiculindus* Radford 1948, from India (1). However, in the type species, *T. squamosus* Radford 1948, the posterior portion of the venter is likewise covered with scales, whereas in the two new species, none of the ventral setae are so modified. All other generic characters agree with *Trombiculindus*, and in order to avoid further complicating the confused systematics in this group of mites, the new species are here described as belonging to this genus.

Trombiculindus foliaceus sp. nov.

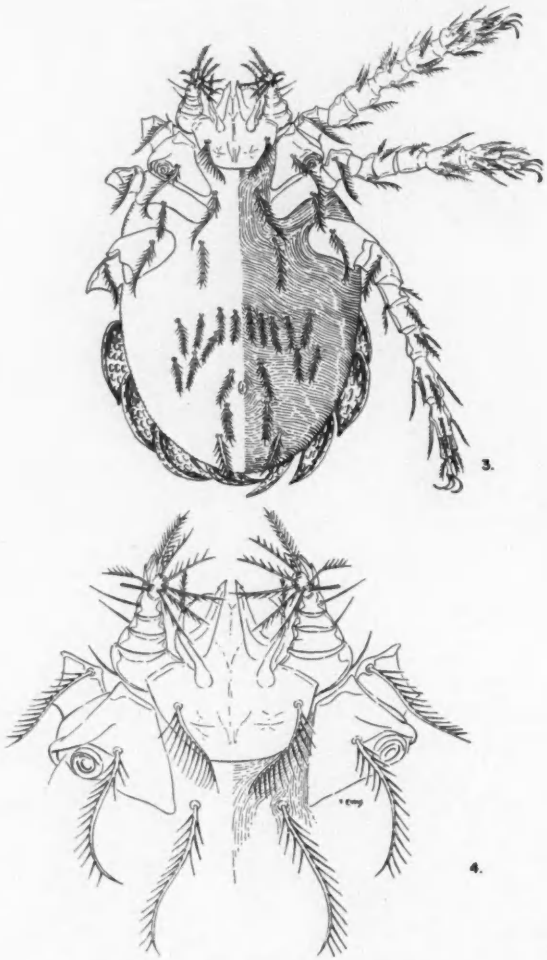
Larva (figs. 1–4).—*Body:* Outline subovate; dorsum and venter with fine parallel but at times whorled striations; length 0.43 mm., width 0.24 mm. *Dorsal plate:* Slightly over two times as broad as long; subrectangular; anterior margin almost straight; lateral margins biconvex, the height of the convexity at the anterior fifth, at the insertion of the posterolateral bristles; posterior margin straight; surface punctate. Sensilla with proximal half naked; apical portion sparsely barbed; with apical half or two-thirds extending distad of scutum. Bases of sensilla inserted far posterior of posterolateral setae, at about level of posterior third of scutum. Anterolateral setae short, plumose. Anteromedian bristle longer and broader than anterolaterals, plumose; inserted far posterior of anterior margin, further than one-third of scutal length. Posterolateral setae heavily foliate; ovate; about half as broad as long, about four-fifths as long as the dorsal plate is broad; flattened; rugose, with dorsal and ventral surfaces bearing seven to nine parallel contiguous rows of striations formed by a chain of subquadrate cell-shaped bodies

[1]Published under the auspices of the Surgeon General, U. S. Army, who does not necessarily assume responsibility for the professional opinions expressed by the authors.



TROMBICULINDUS FOLIACEUS SP. NOV.
DORSAL ASPECT

Trombiculindus foliaceus, n. sp. FIG. 1, dorsal aspect of larva. FIG. 2, dorsal aspect of gnathosoma and scutum.



TROMBICULINDUS FOLIACEUS SP. NOV.
VENTRAL ASPECT

Trombiculindus foliaceus, n. sp. FIG. 3, ventral aspect of larva. FIG. 4, ventral aspect of gnathosoma and coxae I.

TROMBICULINDUS CUNEATUS SP. NOV.
DORSAL ASPECT

Trombiculindus cuneatus, n. sp. FIG. 5, dorsal aspect of larva. FIG. 6, dorsal aspect of gnathosoma and scutum.

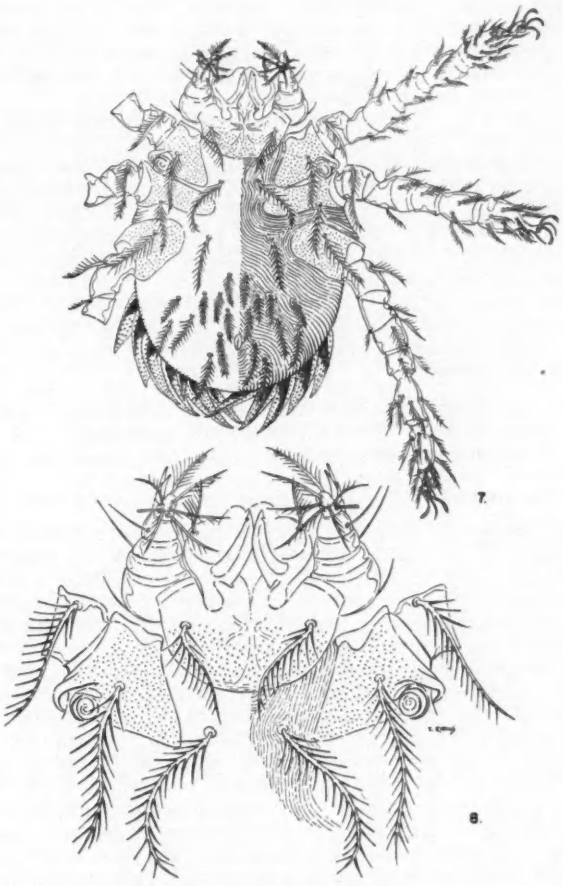
or stout verrucae extending from base to apex. Ventral striae of posterolateral setae vacuous, more cellular, unpigmented. *Eyes:* Tangential to lateral margin of scutum; posterior to insertion of posterolateral setae; cephalic eye almost twice diameter of caudal eye. *Chelicerae:* Acuminate; about four or five times as long as broad at base; with a single, small subapical notch. *Palpal claw:* Trifurcate, with middle (dorsal) prong the longest, almost twice length of outer prong, but only slightly longer than inner prong. *Palpal tarsus:* Slightly longer than broad; with seven sparsely plumed bristles (one dorsal and six ventral) and a ventral, short proximal spur. *Palpus:* With a naked, dorsal seta on palpal trochanter, another on genu; tibia with a somewhat plumed dorsal bristle, a tiny nude one, and a nude ventral bristle. *Galea:* With a ventrolateral plumed bristle. *Dorsal setae:* Similar to posterolaterals in being foliate, flattened, ovate and bearing dorsal and ventral parallel rows of striae consisting of chains of cell-shaped bodies or verrucae, but somewhat longer in relation to width, being more than twice as long as wide. Their flattened surfaces cover virtually all of dorsum. About 26 or 28 in number, the anterior rows arranged 2:8:6:6 . . . *Coxae:* Unisetose, plumose. *Sternal setae:* A pair of plumose setae between bases of first two pairs of coxae and another pair between bases of coxae III. *Ventral setae:* Plumose, about 20 in number, of which the most posterior six are in three rows of two each. *Legs:* I—0.23 mm.; II—0.21 mm.; III—0.25 mm. Sensory setae as follows: I—two genualae, two tibialae, one microtibiala, one spur, one microspur laterad to spur, one subterminala, one parasubterminala and one pretarsala. II—one genuala, two tibialae, one spur, one microspur laterad to spur and one pretarsala. III—one genuala and one tibiala. *Tarsal claws:* Elongate, acuminate; middle claw slightly thinner than others.

STANDARD MEASUREMENTS (in microns)

Slide No.	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS	Width DS
646–15 Holotype	68	84	39	25	14	14	53	35	67	60	63	35
650–4 Paratype	63	81	39	28	16	12	..	28	67	..	67	26
650–1 Paratype	67	77	39	28	14	12	..	35	67	..	63	28
757–7 Paratype	65	81	35	28	14	12	50	28	67	..	67	35
757–8 Paratype	67	84	42	25	14	14	49	32	60	..	60	35
650–7 Paratype	67	84	39	25	16	14	..	28	73	..	67	32
649–19 Paratype	67	84	39	25	14	12	..	28	60	..	60	35
Mean.....	66	82	39	26	14.5	13	51	31	66	60	64	32

Type Material.— *Holotype* (United States of America Typhus Commission No. 646–15) and one *paratype* deposited in the collection of the United States National Museum, Washington, D. C. *Paratypes* deposited in the British Museum of Natural History, London, the South Australian Museum, Adelaide, and the Rocky Mountain Laboratory of the U. S. Public Health Service, Hamilton, Montana.

Records.— *Holotype* from *Crocidura* sp., a small shrew; Shingbwiyang, Burma, 13 February 1945, coll. U. S. A. Typhus Commission. *Paratypes*, same data, but February and March, 1945.



TROMBICULINDUS CUNEATUS SP. NOV.
VENTRAL ASPECT

Trombiculindus cuneatus, n. sp. FIG. 7, ventral aspect of larva. FIG. 8, ventral aspect of gnathosoma and coxae I.

Trombiculindus cuneatus sp. nov.

Diagnosis.—Near *T. foliaceus* sp. nov. but with posterolateral bristles and bristles of dorsum relatively longer, cuneiform or shaped like a spearhead, resembling an isosceles triangle with convex base and altitude about four times the base, not merely about twice as long as broad. The five or six carinae on these modified bristles resemble minute spiniforms and are non-vacuolate.

Larva (figs. 5–8).—(Only differences from previous species are noted.) Length 0.28 mm., width 0.18 mm. Dorsal plate with anterior and posterior margins straight, parallel. Posterolateral bristles inserted at level of anterior two-fifths of scutum. Eyes with anterior and posterior portions subequal. Palpal tarsus with six sparsely plumed bristles (one dorsal and five ventral); with a ventral proximal spur. Dorsal setae agree with posterolaterals in being flattened subcuneiform and with five or six parallel carinae extending length of bristle, but smaller in proportion, often narrower. With about 18 ventral setae, arranged approximately 2:6:6:2:2. Legs with measurements and sensory bristles as in *T. foliaceus*, with following exception: first leg bears an additional bristle, a microgenuala.

STANDARD MEASUREMENTS (in microns)
(Based upon study of holotype and 15 paratypes)

AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	Sens.	DS	Width DS
70±4	85±6	44±2	26±2	16±2	16±2	63±3	31±4	60±7	68±5	58±5	18±3

Type Material.—*Holotype* (United States of America Typhus Commission No. 414–22) *ex Crocidura* sp., Myitkyina, North Burma, 29 November 1944, coll. U. S. A. Typhus Commission. Twenty-five paratypes with same data, or from *Crocidura* or *Suncus*, same locality, November 1944 through February 1945, or from *Crocidura* collected at Shingbwiyang, Burma, February 1945.

Remarks on the Genus Trombiculindus.—It is noteworthy that despite intensive collecting, particularly at Myitkyina, *T. cuneatus* and *T. foliaceus* were collected only during the dry season and that during that time of the year these species were abundant. According to the original description, *T. squamosus* was collected during October in the Kumaon Hills. No mention is made as to the season. However, October is a dry month in many parts of India. It is suggested that the modification of body bristles into foliate scales in this genus is adaptive in nature and serves as a protection against desiccation. The sensitivity of certain trombiculid mites to moisture is marked. Changes in the abundance of the mite population, as correlated with rainfall, have been noted and discussed elsewhere (2, 3).

CITED REFERENCES

1. **Radford, C. D.** 1948. *Trombiculindus squamosus*, gen. nov., sp. nov. Proc. Zool. Soc. 118(1): 126–128.
2. **Traub, R.** 1949. Observations on tsutsugamushi disease (scrub typhus) in Assam and Burma. The mite, *Trombicula deliensis* Walch, and its relation to scrub typhus in Assam. Amer. Jour. Hyg. 50(3): 361–370.
3. **Traub, R.,** and **Frick, Lyman P.** 1950. Chloramphenicol (Chloromycetin) in the chemoprophylaxis of scrub typhus (tsutsugamushi disease). V. Relation of number of vector mites in hyperendemic areas to infection rates in exposed volunteers. Amer. Jour. Hyg., 51(2): 242–247.

STRUCTURAL FEATURES OF THE OOTHECAE OF CERTAIN SPECIES OF COCKROACHES

(Orthoptera, Blattidae)[1]

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Preliminary insecticidal experiments with egg capsules of common species of cockroach led directly into the observations reported in this paper. Results of early tests using oil base liquids indicated clearly that toxic action was taking place *within* the egg case, which immediately raised a question as to the mode of entry; respiration of the enclosed embryos was another basic point brought up for consideration at this time. Since it is known that a certain amount of gas exchange takes place through the shell of the egg of various insects, it did not seem logical that cockroach species should be different. Yet the blattid ootheca has heretofore been considered a sealed structure.

From a respiratory standpoint, the embryological development of all species studied is completely walled-off from the body of the female; in all but the German cockroach the capsule is dropped and is devoid of further association with the mother for several weeks. Direct diffusion seemed an unlikely means of gas exchange, since the capsule wall is thick and heavily chitinized after exposure to air; it was likewise doubtful that the producing female could seal sufficient air within the capsule to support respiration over a period of weeks. The alternative, therefore, was that the eggs of all species, with the possible exception of the German roach, had a direct gas connection with the outside; as the investigation progressed, however, it became evident that not even this species was exceptionally different in this respect.

The species for which such atmospheric connections are described in this paper are the German roach, *Blatella germanica* L., the Pennsylvania Wood roach, *Parcoblatta pennsylvanica* Degeer, the Brown-banded roach, *Supella supellectilium* (Serv.), the Oriental roach, *Blatta orientalis* L., the American roach, *Periplaneta americana* L., and the Brown roach, *Periplaneta brunnea* Burm. Research facilities of the Zoology and Entomology Department, Ohio State University, were utilized during these investigations.

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[1]Part of a dissertation presented for the degree of Doctor of Philosophy, Department of Zoology and Entomology, The Ohio State University.

Deep appreciation is extended to Dr. D. M. DeLong for encouraging and supervising the pursuit of this problem; to Dr. C. H. Kennedy for encouragement and the use of certain literature; to Mrs. Shreck, the librarian, and Mr. L. H. Isenburg, for assistance with difficult translations; to Dr. Carl Venard and Mr. Floyd Mizell for a supply of Brown Banded Roaches; and to Mr. A. C. Miller, Gulf Research and Development Co., Pittsburgh, Pa., for supplying American and Oriental capsules when they were not otherwise available.

[2]Contribution No. 39, Department of Zoology and Entomology, The University of Tennessee.

LITERATURE

Dufour (1834) mentions an "appareil serifique," a gland the function of which was to secrete a "silk-like material" for the fabrication of a cocoon which would enclose the eggs. Westwood (1839) describes the capsule as a large horny case with one of the edges more compressed than the other; the slit between the keel parts and the interior of the capsule are given some attention, along with a designation of the two halves of the seam as a pair of protective serrated plates. Huxley (1878) credits the colleterial glands with the secretion of the capsule material.

Kadyi (1879) and Hallez (1885) discuss the fabrication of the capsule and the oviposition characteristics of *Blatta orientalis*. The vaginal space is filled with the colleterial secretion, which contains tiny crystals of calcium oxalate; this substance was reported as being of a non-chitinous nature until after exposure to air. The eggs are deposited within this mass, and, as the cavity fills, the caudal portion of the growing capsule is forcibly extruded. More secretion and more eggs enter the vaginal cavity until the full complement of eggs has descended and the capsule is completed. The eggs descend alternately from the opposing ovaries and come to rest along the side of the vaginal cavity opposite that of their origin.

Wheeler (1889) illustrates a cross-section of the keel of the German roach capsule and goes into considerable detail on the mechanics of egg placement within the vaginal space; he also describes the origin of a pear-shaped cap of epithelial cells which accompanies the egg down the oviduct and comes to rest within the lumen of the seam. This structure probably corresponds to the "white body" described in the sections of this paper dealing with *B. germanica* and P. *pennsylvanica*. The presence of a "vacuolated substance" filling the remainder of the seam space was not verified. This writer further reports that "the rhythmical clasping of the three pairs of palpi, which guard the vaginal opening, is registered in an exquisite pattern on the inner face of either half of the seam." Beyond this statement no reference to seam structures has been found in the literature.

Shelford (1912) makes general observations concerning the outer appearance of several species of oothecae but scarcely mentions the interior arrangements of any of them. Ross (1929) reports on the nature of the capsule wall and the internal arrangements in oothecae of *B. germanica*.

METHOD OF STUDY

The oothecae of all species were examined primarily in strong reflected light; the structures built into the seam of each capsule were thus revealed as regularly spaced points of less density, as evidenced by a brighter color. Direct illumination was of necessity employed on capsules whose walls were extremely dense and for the examination of all interior features.

The hollowness of the seam structures, and their connection with the outside, was demonstrated by the use of certain liquids. One of these was an emulsion of a commercial DDT product; the oil droplets were very small but their movements were easily observed through the thin seam-structure walls as the emulsion flowed into the capsule.

The second liquid employed was a highly refined kerosene solvent; when it was applied to the capsule seams, the structures were filled and the differences in color were at once removed. A deep red saturated solution of Sudan IV, in this solvent, was used in tracing the pathway of the liquids inside the egg case.

A simple lime water-carbon dioxide respiration test was set up as a preliminary attempt to demonstrate the probable gaseous exchange through the keel structures; the results were positive but rather faint with capsules of *P. americana*. This was followed by routine tests (with *B. orientalis* capsules) on a Warburg respiration apparatus,[3] the results of which were also positive. Work along this line is to be continued in the near future.

CAPSULE DESCRIPTIONS

The oothecae of the six cockroach species listed previously are described in order of decreasing complexity of seam structures and internal arrangement: the first two are quite similar and are highly complex, the third occupies an intermediate position, and the last three represent a natural group based on almost equal simplicity and similarity of structures and arrangements.

The German Roach (Figs. 1–10)

The walls of the egg capsules of this insect usually are thin, pliable, and more or less transparent; in most the color is found to be a reddish brown at the free end shading to almost white in that portion clasped between the female genital plates. Newly completed capsules forcibly removed from the females have extremely soft white walls that often are thickly interspersed with bubbles. The eggs are completely enclosed by the capsule wall, which is made up of a continuous layer except in the median longitudinal area above the cephalic ends of the ova. Here each of the opposing edges divides into an inner and an outer layer, which when the capsule is closed form the floor and the roof of the seam proper. The lower (inner) layers continue mesally across the tops of the eggs but do not quite meet on the median line, while the upper (outer) layers arch upward then curve gradually to a closure along the center line of the capsule. This essentially horizontal portion of the outer layers paralleling the line of closure is designated the face. Each of these layers bears a minute inflexed edge, so that when the capsule is closed the smooth adjoining projections form a tiny ridge extending downward into the seam space (fig. 6.) The lumen thus enclosed is continuous along each side but is partially divided down the middle by the above ridge and a row of "white bodies" below, which are yet to be described.

Externally the junction of the upper two seam layers is marked by a scarcely discernible row of short, arching, slightly elevated ridges (fig. 3,P); from a point about two-thirds distally along the length of each of these, and more or less basally on either side, arise opposing curving ridges (figs. 3,4) which extend outward and then longitudinally along the seam length in the direction of the attached end of the capsule.

[3]Through the courtesy of Mr. R. E. Neiswander.

In lateral view (fig. 4) the ridge on each side is usually almost straight and slopes gently downward from the point of origin; the termination of each is approximately in line with or just beyond that of the mesal elevation of which it is a part. The surface of the seam is almost completely covered with microscopic circular impressions.

A minute cell (figs. 3, 4-B) is found in each of the mesal elevations and is located just beyond the point of origin of the paired lateral ridges just described. In dorsal aspect these cells have a shape resembling a four-leaf clover; the two longitudinal extensions are rounded at their terminations, while the lateral wings terminate in holes through the walls of the elevation, as indicated by faint brown circles discernible in properly directed light at high magnification. Laterally each cell is seen as a somewhat egg-shaped, translucent area in the body of the mesal elevation; the holes leading to the lateral wings are sharply visible from this aspect. A tube (figs. 4, 5-C) arises at an angle from the proximal end of either half of each of the cells, bends abruptly

EXPLANATION OF PLATE I

Blatella germanica L. FIG. 1, side view of capsule. FIG. 2, dorsal close-up of seam end. FIG. 3, dorsal view of portion of seam, highly magnified. FIG. 4, side view of portion of seam, highly magnified. FIG. 5, inside view of seam, one outer seam wall cut away; inner face of opposite wall (A) showing structures, with spongy bodies below. FIG. 6, cross-section of seam. FIG. 7, dorsal view, seam completely removed above base; white bodies and tops of eggs shown. FIG. 8, two normal and one abnormally developed eggs, with associated white bodies, dorsal view. FIG. 9, dorsal view, end of row of white bodies; center body removed to show pit into which anchored; line of fusion of base of removed body across top of egg also shown. FIG. 10, inside-the-capsule view of seam floor and tops of egg spaces.

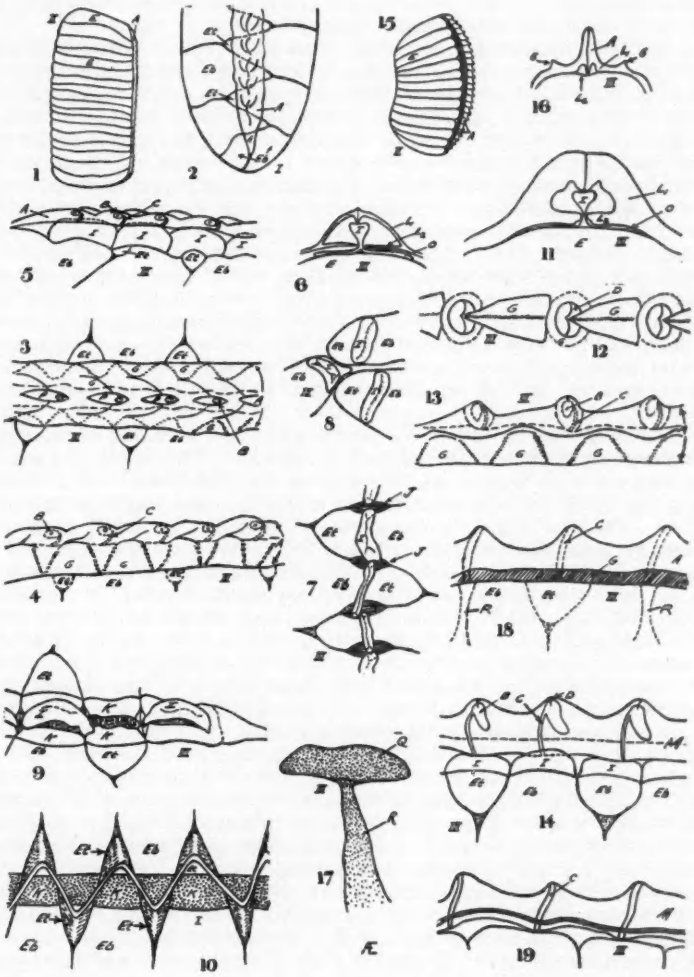
Parcoblatta pennsylvanica Degeer. FIG. 11, cross-section of keel. FIG. 12, dorsal view of portion of seam. FIG. 13, side view of same part of seam. FIG. 14, inside view of keel face with one-half of keel wall cut away; seam structures and white bodies visible.

Supella supellectilium (Serv.) FIG. 15, side view of capsule. FIG. 16, cross-section of keel. FIG. 17, cellular layer leading into egg body space on inside of capsule wall; highly magnified. FIG. 18, side view of portion of keel. FIG. 19, inside view of keel face with one outer wall cut away; shaded band indicates minute shallow groove.

ABBREVIATIONS USED IN PLATES

A—the keel proper.
B—cell within the keel.
C—tube connecting cell with interior.
D—sutural opening to outside.
E—egg.
  Eb—egg body.
  Et—egg termination.
F.—shoulder, marking boundary of inner keel face with inside surface of curved part of capsule wall.
G—elevated ridged area.
H—striations.
I—sponge-like body.
J—pit into which sponge-like bodies are anchored.
K—seam floor.
L—laminae or layers of divided capsule wall.
  L^1—upper layer of lamina.
  L^2—lower layer of lamina.
M—inside face of one-half of keel.
N—inside surface of capsule wall below keel.
O—thickened layer, below seam floor and on top of eggs.
P—central elevation.
Q—top of egg shell.
R—white band (cellular layer).

Roman numerals associated with figures indicate scale as follows:
I, 1″= 1.08 mm.; II, 1″= 3.25 mm.; III, 1″= 0.54 mm.



downward in the middle, and extends through the inflexed seam-half layers to the interior of the seam. Dorsally these tubes have the appearance of small, arc-shaped, barely visible light colored streaks; their connection with the lumen of the keel can be verified by examining one-half of the inflexed ridge of a dissected capsule.

A slightly sinuous but persistent white band down the middle of the interior of the seam is visible through the transparent walls; when one side of the keel face is removed, the white band is found to be an upright row of sponge-like bodies (figs. 5–9,I) occupying the median area of the keel floor and usually extending upward to touch the inflexed ridge of the keel roof. The approximate center of the top of each such body corresponds in position with the termination of one pair of the curved tubes leading down from the air cell above (fig. 5). These structures are composed of an almost pure white substance which is very light in weight and extremely fragile; they are about two-thirds as high as long and only about one-tenth as thick. The top of each is more or less indented along the longitudinal axis (figs. 7–9), giving the appearance of having been tucked in down the center. They are firmly united with the tops of the eggs below and usually, but to a lesser extent, with each other at the terminal points of contact. The row formed by these bodies is not quite straight, since each is usually offset slightly from its neighbors (fig. 7).

Each of these structures is clearly associated with one of the eggs enclosed within the main body of the capsule. The length of each is almost exactly the same as the width of the mesal termination of the egg (fig. 7, Eb and Et), at the point where it crosses beneath the seam floor. The abutting ends of each two white bodies are firmly anchored into very small, triangular median indentations in the seam floor (fig. 7, J); these pits are so located that the extension of each (below the seam floor) slightly separates the adjoining chorion layers of interlocking egg terminations. This association was conclusively established with the finding of an imperfectly formed egg (fig. 8) in one of the dissected capsules, the mesal termination of which (fig. 8, Et) did not extend to the seam floor. The associated white body (fig. 8, I) was likewise out of line and was undoubtedly a part of that deformed egg. The remaining eggs and spongy bodies in that capsule were in the normal position.

A thickened longitudinal layer of approximately the same width as the seam transverses the tops of the eggs (fig. 6,0); it is located directly beneath the floor of the seam and probably is continuous with the spongy white bodies above. It appears to be penetrated by the tiny pits into which the ends of the white bodies are anchored; the specific origin and nature of this layer have not been determined.

The interior spacing of the eggs is indicated by narrow brown lines which are visible through the capsule wall. Immediately laterad of the seam base these lines are found in an alternately spaced, inverted Y-shaped arrangement; the stem of each "Y" then continues as a single line around the side of the capsule where it terminates as two very small half circles which surround the caudal ends of neighboring eggs. It is thus revealed that the interior of the capsule below the seam is tightly packed with two rows of eggs, with each egg in either row being slightly offset from these opposite. Each egg has a bluntly V-shaped

mesal termination which extends beneath the seam floor and fits into the space between the terminations of two eggs in the opposing row. The extension of each egg termination slightly beyond the base of the seam gives rise to the inverted Y-shaped brown lines seen from the outside. The caudal ends of the eggs apparently are under less pressure since the mesal terminations on this side of the capsule are seen as rounded, sometimes slightly separated lines.

When live unhatched capsules were dissected, it was found that the brown lines seen externally were nothing more than the doubled-up chorion layers brought together by the pressurized spacing of the eggs. Each egg is surrounded by its own chorion, which is composed of two very thin layers of material separated (or held together) by minute pillars or trabeculae (Wheeler). These are arranged in roughly hexagonal patterns and are visible under high magnification only. The study of trabecular patterns in various parts of the capsule shows that the longitudinal divider and lateral pockets mentioned by previous writers are nothing more than the doubled-up chorion layers which remain in place and become dry and brittle after hatching. Small pieces teased away from the inner face of the capsule wall (between lines) reveal a single set of hexagonal configurations, denoting only one layer of chorion; samples taken from the "lateral partitions" and from the "longitudinal divider" exhibit double sets of such patterns, which, in addition to being seen at slightly different focal levels, show considerable lack of coincidence. The two thicknesses of chorion thus revealed could by careful manipulation be separated into single layers possessing but one set of patterns. A single layer of chorion is found on the tops of eggs.

During the process of hatching the pressure of the expanding nymphs apparently is exerted dorsally, rupturing the single chorion layer on top of the egg and lifting back the two halves of the seam. The seam floor layer of the capsule wall is seen as a narrow, transparent shelf just inside the opened lips of the capsule; occasionally a small amount of the white body substance is found stuck to inner edge of this layer. The white bodies remain for the most part as a white crest on the center row of staggered chorion walls. The position formerly occupied by each egg is indicated by the two rows of egg shell walls.

The action of the dyed oil within the capsule of this species was noted as an interesting sidelight during these investigations. It was found that, a short time after the solution was applied, a change of color and refraction occurred in one or more of the egg spaces. The line of change advanced rapidly, apparently along the inside face of the capsule wall, and gathered in quantity at the posterior ends of the eggs. The only possible way of entry is by means of the white bodies (which took up and held the red color) and their connection with the eggs below, since the remainder of the seam floor is composed of an impervious layer of chitinous capsule wall material.

The Pennsylvania Wood Roach (Figs. 11–14)

On the basis of seam structures and egg arrangement, the ootheca of this species indicates a much closer relationship to the German roach than is to be seen in adult morphological and ecological character-

istics. The capsules of the two species are quite unlike externally but the basic organization of the seam, its contents, and the alternately crossing-under arrangement of the eggs are essentially the same; the inverted Y-shaped lines, indicating this type of egg spacing are, however, very small, and are difficult to see in the fully colored capsules. The walls of the mature egg case of this species are usually much darker in color and are quite horny in composition; newly formed and recently dropped capsules are lighter in color and the walls are more transparent, so that observation of structures can be made with reflected light.

The outer walls of the seam of this capsule slope upward more gradually and end in a more rounded dorsal face than was found in the ootheca of *B. germanica*. From the side a serrated crest is seen, with rounded lateral projections near the top which are continuous with the elevations on the summit. From above these dorso-lateral enlargements are connected by slightly elevated wedge-shaped structures (fig. 12-G), each of which begins as a narrow neck-like ridge distally, widens abruptly, and then tapers sharply into the proximal side of the next elevation in the series. The point of junction is reached, however, before the taper has come to a point.

Each of these dorso-lateral projections contains a hollow cell from near the top of which a fine tube curves downward in a flat arc toward the interior of the seam. The top of each enlargement is cut, transversely to the longitudinal axis of the capsule, by a short but prominent suture. The lips of this slit are darker in color and usually appear to be tightly closed, but a ready inflow of liquids indicates that they constitute the atmospheric connection with the cell. The cells vary from egg-shaped oval to long and tooth-like in outline; the wider end is dorsal and usually varies only slightly in size or shape, while the lower end exhibits a greater amount of variability among different capsules of this species. The cells and tubes are made up of opposing halves (fig. 14), which are mirror-image depressions in each of the inflexed faces of the dorsal seam walls

The inflexed portion of each of the dorsal keel layers is comparatively thick in the vicinity of the cells but tapers rapidly below; very thin, closely appressed extensions of each side carry the terminal portion of each tube deeper into the lumen of the seam. This projecting plate-like extension is more or less emarginate along the inner margin, with the greater depths being found directly above the spongy bodies and each bearing the inner apex of one of the connecting tubes. The keel floor is formed of the lower laminae (fig. 11, L^2), which are much thicker than those found in *B. germanica* capsules.

Along the median line of the keel floor is found a centrally located row of sponge-like bodies very similar to those found in the egg case of the German roach. The individuals in the row are noticeably staggered in alignment and each body is obviously associated with an egg; each body is anchored to the seam floor along its own length and into little pits at either end. These bodies in *P. pennsylvaniac* exhibit a decided brownish-yellow tinge of color and each is provided with a dorsal longitudinal crease and a pair of somewhat rounded lateral indentations. The dorsal indentation corresponds in location to the position of a projecting continuation of the vertical faces from above;

the top of the spongy body and the lower margin of the inflexed extension (with the tip of the tube) are usually but not always in contact and it is apparently through this arrangement of structural elements that the enclosed eggs maintain atmospheric connections.

In cross-section (fig. 11) the seam walls are thick, the lateral lumen space is relatively small, and the lower laminae are thick and horny. The spongy bodies thus occupy a comparatively greater portion of the interior space of the seam than was found in the oothecae of *B. germanica*. The substance of the white bodies remains almost entirely on the crest of the central row of interlocking egg-shell walls which are left at hatching time. The two rows of "egg pockets" left by the upright doubled chorion layers are also seen in the empty capsule, but they usually are ripped open to a greater depth than in capsules of the croton bug. The walls of the capsule are quite elastic in nature and usually return to the typically closed position after hatching has been completed.

The Brown Banded Roach (Figs. 15–19)

A keel having walls split into upper and lower layers, a seam floor, and tightly packed eggs extending alternately beneath the seam are characteristics which relate the egg-case of this species to both the German roach and the Pennsylvania Wood roach, but the absence of a row of sponge-like bodies along the center line of the lumen floor represents a major difference. The capsule of this roach is only about half the size of that of *B. germanica* and is not carried more than a few days by the female. The color of the detached capsule is usually light brown to tan darkening with age; the fully developed color of this egg capsule is much darker than that of the German roach ootheca but is lighter than the deep brown of the Pennsylvania Wood roach capsule. The back side is considerably shorter than the opposite and is much straighter; the ends of the capsule are thus sharply angled away from the seam side (fig. 15).

In cross-section the seam walls of this species of egg capsule are thin as compared to those of the Pennsylvania Wood roach but are much thicker than those of *B. germanica;* the lower plate which forms the seam floor splits away from the outer wall at a point considerably further back under the curvature of the shoulder than in the capsules of the preceding species. In most oothecae examined this layer was comparatively hard and brittle.

Dorsally the seam presents a narrow face which is sharply delineated on either side by a small but definite perpendicular ridge (figs. 16, 18-G). The median line of the keel face is occupied by a row of prominent, tooth-like projections which rise abruptly from the more or less horizontal portion of the seam face; these connect with each other in the row, so that an evenly serrated outline is seen when the seam is viewed laterally. The remaining surface of the seam face (between lateral ridges and serrated median row) varies from slightly concave to almost flat. The opposing halves of the seam meet as vertical faces which are extended into the comparatively small lumen of the seam. The keel floor is formed of the lower laminae which separate from the capsule wall slightly beyond the outer seam margin and extend inward across the tops of the eggs.

Each tooth of the median row contains a tube (fig. 18-C) which curves downward from the apex and is carried into the lumen by the extensions of the vertical faces. Each assembled tube is, of course, made up of opposing halves which are nothing more than grooves in the vertical seam faces. These hollow structures open directly to the outside at the apex of each tooth and do not connect with cells, which have not been found in any of the capsules examined.

The egg spaces within the capsules are set off on the outside by faint dark lines which extend around the sides to the median area opposite the seam; the tiny inverted Y marking the termination of each egg is found on the opposite side of the keel base. These alternate from side to side on the seam base, as was found in the egg cases of the two species already described. By actual count there is an egg enclosed in the capsule for each tooth found in the median seam ridge.

A minute band (figs. 17, 18-R), appearing very thin and white in a concentrated beam of light, arises at the base of the seam and extends a short distance along the inside surface of the capsule wall into the main body of each egg space. These structures are abruptly constricted a short distance from their origin but gradually widen and fade out as they extend down the inside of the egg spaces. The band in each space is directly in line with the tube in one of the teeth of the keel. In very transparent capsules this band can be seen from the outside as a faint brown line extending from the base of the keel.

A dark green band is visible along each side of the older capsules of this species. The color is due to an accumulation of metabolites in the digestive tract of the developing embryos and is mentioned by Ross (1929) and other writers as a characteristic of capsules of *B. germanica*.

The Oriental Roach (Figs. 20–25)

This and the two species which follow constitute a group in which the capsule structure is much less complicated than was found in the three species already discussed. There are no spongy white bodies, no seam floors, and no white bands leading into the egg spaces; in addition, the eggs are usually not so tightly packed into the main body of the capsule and upright rows of double egg shell walls are not left in place at hatching time. The atmospheric connections, an apparently

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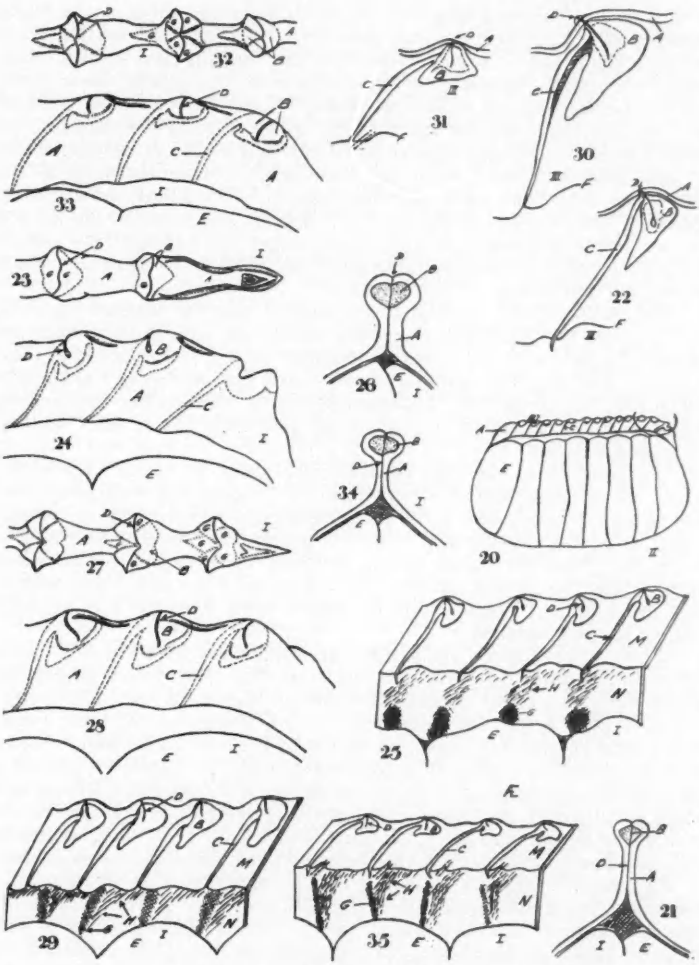
EXPLANATION OF PLATE II

Blatta orientalis L. FIG. 20, side view of capsule; semicircle indicates portion enlarged and illustrated in Figs. 23 and 24. FIG. 21, cross-section of keel. FIG. 22, close-up of cell half from inside. FIG. 23, top view of enlarged end portion of keel. FIG. 24, side view of same area. FIG. 25, inside view of keel face and top of inner capsule wall.

Periplaneta americana L. FIG. 26, cross section of keel. FIG. 27, top view of enlarged end portion of keel. FIG. 28, side view of same area. FIG. 29, inside view of keel face and top of inner capsule wall. FIG. 30, close-up of cell half from inside.

Periplaneta brunnea Burm. FIG. 31, close-up of cell half from inside. FIG. 32, top view of end portion of keel, enlarged. FIG. 33, side view of same area. FIG. 34, cross-section of keel. FIG. 35, inside view of keel face and top of inner capsule wall.



For explanation of Abbreviations used in plates see page 272.

fundamental provision in all capsules, are quite similar in the oothecae of the three remaining species.

The attached end of a capsule prematurely removed from a female of this or the following species is found to be composed of a soft white material which is thickly interspersed with bubbles of varied diameter; within a few hours, however, the bubbles have disappeared and the white end of the capsule has assumed natural color. The eggs within a newly formed capsule do not adhere as closely to the walls as they do later in their development; during the early white stage of the capsule, the caudal ends of the eggs appear to be floating in the enveloping mass of colleterial secretion, while the dorsal ends are tightly packed into the upper narrowed part of the capsule. The sharp brown lines, denoting the location of the eggs in the matured capsule, are absent or very faint and wavy at this time. After the capsule has become fully hardened and has been dropped by the female, the sides are evenly brown and are horny in composition.

The walls of the capsule are produced sharply upward (fig. 21) to form the two halves of the seam, which are closely appressed and apparently are more or less sealed together for a greater portion of their height. The keel thus formed is prominent and stands upright above the mesal line of junction between the dorsal ends of the eggs below. Externally the union of the two sides is marked by a faint median longitudinal suture.

The position of the eggs is shown externally by sharp lines which curve into more or less of an inverted "U" along each wall just below the base of the keel and unite into single lines which carry on around the sides of the capsule and round off about the caudal extremities of the eggs. The end spaces of the oothecae are occupied by unpaired eggs, except for the one similarly located on the other end; those of each side are paired in slightly offset position with those on the opposite wall of the egg capsule.

When viewed from inside the egg case, each inverted "U" configuration is found to correspond to a curving ridge which marks the upper limit of a slight depression in which the egg is seated; the lines between eggs along the sides may be indicated also by faint ridges which usually extend a slight distance into the capsule interior. When such an extension occurs, it is continuous with the capsule wall and is quite obviously made up of the same transparent material. The lateral shells of adjoining eggs are pressed together along each side and in this manner a double egg shell dividing wall is formed. An hexagonal trabecular pattern was found in the chorion of the eggs of this species.

At intervals along the length of the upper portion of the seam are found the small evaginations (fig. 23) which have given rise to the descriptive term "toothed seam," which is commonly applied to this type of keel. From above, the evaginations vary from rounded to wedge-shaped on each side; laterally they usually appear oblong and slightly rounded, with the longer axis vertical. The top of each such tooth is considerably wider than the base and extends above the common crest of the seam. The spaces between teeth along the crest may be either smoothly rounded from tooth to tooth or may slope directly from the top of one down to the lower-level junction with the next;

in either case these emarginations are regularly produced. The dorsal surface of the seam between teeth is not always flat, often sloping gently from the center into sharp lateral edges.

Each of these "teeth" contains a hollow cell (fig. 24-B), from near the top of which a tube (fig. 24-C) curved down through the lower, apparently sealed part of the seam. The cells are formed of opposing halves which are slightly rounded at the top, taper somewhat to the bottom, and may be either acutely or roundly excavated laterally. The tube, which has been previously figured only as a line, is also divided into opposing parts, which are almost triangular in cross section near their point of origin at the cell but become attenuated and flattened with distance. The direction of curvature of the tubes is toward the free end of the capsule, which is considered an indication that its formation is a function of the deposition of the egg. There is one such cell and tube system for each of the eggs within the capsule.

Across the top of each lateral portion of the cells is a sharply curved line or suture (fig. 24-D) which runs in a direction more or less at right angles to the main axis of the egg case. Sharply defined ridges mark the position of the curved lateral portions of the suture, but that part which crosses the center of the seam and connects the curved laterals may have no ridge and is at times quite indistinct. The opposing lips of this suture have been found either closely appressed or gaping widely (fig. 24). The termination on each side of the cell, when the lips are closed, is a small rounded opening (fig. 24); proper alignment of both openings allows direct transmittal of light. The continuity of the seam structures with the rounded lateral openings is easily demonstrated by application of the liquids previously mentioned.

On the interior surface the base of the keel forms a definite shoulder (fig. 30-F) along the line where it merges with the curved sides of the capsule. The tube described above extends to this shoulder in practically all capsules; in many it continues slightly "around the corner" and terminates a short distance down on the inner face of the capsule wall. Some distance below this point is the upper arc of the curved ridge delineating the space occupied by the egg (fig. 25-E); the capsule wall is thicker in this area than inside the egg concavity. Very broad but scarcely discernible elevations extend across this thicker portion of capsule wall from about the termination of the tube to the top line of the egg seat; there may occasionally be only one of these elevations but usually two are found leading to each concavity. The surface of each such wide ridge is marked by a varying number of extremely fine striations, the direction of which varies from vertical to oblique. Additional striations are found alongside these broad elevations and to a greater or less extent along the shoulder line of the capsule wall. These striations are not, however, as numerous or pronounced as they are in the capsule of the American roach.

The American Roach (Figs. 26–30)

The ootheca of the American roach is quite similar in general appearance to that of the Oriental, but variations are found in size, weight, and in certain seam characteristics. Both typically contain sixteen eggs, although there are often fewer and very rarely more.

Under similar conditions the eggs of *B. orientalis* usually hatch in seven to eight weeks as compared to about six weeks for *P. americana.*

The size of the American capsule is roughly about three-fourths that of the Oriental; there is, of course, a considerable range in over-all dimensions so that an overlapping of size occurs among oothecae of the two species. Weighing experiments, with data on 1250 capsules, gave an average weight of 80.36 mg., as compared with an average of 128.03 mg. for 1550 capsules of the Oriental roach. These weight averages are based chiefly on capsules containing eggs of unknown age and viability. Newly formed American capsules may vary in weight from about 60 mgs. to more than a hundred, with capsules subsequently failing to hatch initially weighing light. In general there was a considerably higher percentage of hatching among the capsules of *P. americana.*

The transverse suture in the top of the cell does not terminate in a rounded opening (fig. 28-D), as was found in the capsule of *B. orientalis;* the suture is present, however, and its connection with the interior structures can be demonstrated. Entrance of the stream of oil droplets into the suture took place at different points in various capsules; in one instance a stream entered one air cell laterally and emerged dorsally from another three spaces down the keel. The two edges of the suture have an appearance of being stitched together; dorsally the ridges (fig. 27-D) which mark externally the position ot the suture take a sharply curved position across the top of the cell. The occurrence of an imperfectly closed suture across the top of one or more of the cells was extremely rare in this species.

The cells inside the evaginated teeth of the seam (fig. 30) are considerably more triangular in outline than they were in the capsules of the previous species studied. The top is wider and the sides slope more rapidly toward a more pointed bottom. A grooved projection extends into the cell space just below the point from which the tube opens; this varies in size and depth but such minor grooves are usually present to some extent. The halves of the tube proper (fig. 30-C) are sharply triangular near the cell but change into more or less rounded tubes as they extend toward the lower shoulder of the keel. Viewed from the outside, the outline of the whole tooth is often sharply angular in appearance; the top seems more flat than that of the Oriental capsule, and the lateral extensions (which form the "teeth") are frequently rather sharply ridged up the center. This is especially noticeable in newly formed capsules which have not taken on their final color and hardness. In this connection, it is interesting to note that the cell spaces and tubes are present and fully formed in the soft, bubble-filled material composing the capsules taken prematurely from the females.

The termination of the tube leading downward from the cell (fig. 29) does not often cross the lower shoulder line of the keel, usually ending at the bottom of the keel face just before the ridge is reached. When this occurs, a tiny V-shaped notch breaks the continuity of the shoulder line, usually extending across and connecting both the keel and the capsule wall faces. Frequently there is found, also, a slight depression in the ridge of the shoulder between this minute groove and the termina-

tion of the tube. A striated ridge (fig. 29-G), one for each tube, arises somewhat behind this grooved break in the shoulder line.

As mentioned in the description of the Oriental roach egg case, two raised striated ridges extend down the face of the capsule wall from the base of the seam to the top curvature of the egg seat; since each ridge arises at the termination of a single tube, it would appear that each egg is served by two cells and tubes. Such an apparent discrepancy is explained by the oppositely paired placement of the eggs in the capsule, with one cell and tube for each. Since the eggs are of such comparative size that the upper arc of the seat extends beneath two of the cell and tube systems, the apparent doubling of the structures for each egg is not surprising. However, it seems highly improbable that the striated ridges play a functional part in the respiratory exchanges of the eggs, since open space is usually found in the capsule between the base of the keel and the tops of the eggs.

The capsule wall characteristics, the arc-like ridges over the top of the egg concavities, the walls between each two eggs on the side, and the inward projection of each such wall toward the center of the capsule are essentially the same as was described for the egg case of *B. orientalis*. The interior arrangements are also very much alike, as was the appearance and color of capsules removed too early from the females.

The Brown Roach (Figs. 31–35)

Since the adults and nymphs of this species very closely resemble those of *P. americana*, it is not surprising that there is considerable resemblance between the capsules of the two species. The oothecae are very much alike from a structural standpoint, but those of *P. brunnea* are longer, less rounded laterally, and are much darker in color than are those of the American roach. The depth of the capsule is about the same in both species, but the length of the Brown roach egg case is about 50% greater; the number of eggs enclosed is greater in about the same ratio. Capsules taken from the *brunnea* culture jars were almost black, but the keels gave about the same shade of color in reflected light.

The serrations, cells, and tubes are present in numbers corresponding to the greater complement of eggs within; the teeth appear relatively closer together in the keel, however, than was found in oothecae of the other two species in this group. The number of air cells varied from 22 to 28 per capsule, with an average of 24. Occasionally an extra, poorly formed tube was found, but these were not necessary to make the total count coincide with the number of eggs enclosed.

The cells, although basically similar to those of *P. americana* and *B. orientalis*, are more acutely tipped at the lower extreme and have the top contour more or less concave on the inner surface (fig. 31). The sutural openings across the tops of the cells are very much as in the preceding species. The face of the cell from which the tube arises may be more concave than in the American capsule, but this characteristic is variable. The tube (fig. 31-C) which arises from the cell is somewhat more curved in its downward path than was found in the

capsules of *P. americana;* the cross-section of the tube shows that the triangular outline of the beginning is continued downward for a greater distance than was the case in the preceding two capsules described. There is also a tendency for the tubes to widen slightly in the middle region before tapering to a point; this is indicated by the distal line having a greater amount of curvature than the proximal, with a consequent increase in the diameter of the tube.

The inner termination of the tube may extend slightly beyond the shoulder (fig. 31-F) at the keel-curved wall junction. It does not make a bend or turn as it extends across and fades out. Anterior to the crossing point of each tube a minute depression is found in the sharp contour of the shoulder line; a flat, narrow ridge with a few striations begins at a point just in front of each depression and extends toward the tops of the egg seats. Striations are also found on the inner face of the capsule wall in the neighborhood of the elevations.

SUMMARY

Certain hollow structures discovered in the seam or keel of the oothecae of common species of roaches are discussed in this paper. These structures apparently are built into the seam during the process of capsule formation and were found to be connected with both the outer atmosphere and with the interior of the capsule of the six species examined. Positive results were obtained with a Warburg respiration apparatus using unaltered capsules of *B. orientalis*.

The capsules studied are divisable into two groups which correspond to the different subfamilies to which the species belong; the German, Pennsylvania Wood, and the Brown Banded roaches make up one group, while the Oriental, American, and Brown roaches constitute the other. The first group has oothecae with relatively complicated seam arrangement, while in the second group the structural pattern is quite simple.

The first group is characterized by divided capsule walls in the vicinity of the seam; an inner layer extends across the tops of the eggs to form the seam floor, while the outer layers extend up and over, meet on the center line, and form the roof of the seam. In the German and the Pennsylvania Wood roaches the center line of the seam floor is occupied by a row of sponge-like bodies, one for each egg and each seated across the top of an egg; the cells and tubes are found in the inflexed extensions of the roof layers and are more complicated in the German roach. The capsules of the Brown Banded roach have no row of white bodies and no cells; a tube curves down from the apex of each tooth along the seam center and provides atmospheric connection. A minute band of a thin, light colored substance extends from the keel base into each egg space; each band is in line with the termination of one of the tubes.

The closely related species of the second group have capsules with no divided walls, so that the seam space is not set off by a floor; the cells and tubes are built directly into the appressed upward extensions of the capsule walls. Each cell is indicated externally by an evagination on each side of the upper part of the keel; each also has a transverse sutural opening across the top and connects with the inside by way of a curving tube.

The eggs contained in capsules of the first group are tightly packed within and meet in a staggered row down the center line; the top of each egg extends mesally across beneath the seam floor. In the second group the eggs are tightly packed in offset rows only at the cephalic ends, where they fit into the narrowed space below the keel; the more caudal portions of the eggs are seated along each wall of the capsule and are not necessarily in mesal contact.

LITERATURE CITED

Dufour, L. 1834. Récherches anatomiques et physiologiques sur les Orthoptéres, les Hymenoptéres et les Neuroptéres, pp. 370–373.

Hallez, P. 1885. Orientation de l'embryon et formation du cocon chez la *Periplaneta orientalis*. Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences (Paris), 101: 444–446.

Huxley T. H. 1878. A manual of the anatomy of the invertebrated animals. Appleton and Co., N. Y., 360 pp.

Kadyi H. 1879. Beitrag zur Kenntnis der Vorgange beim Eierlegen der *Blatta orientalis*. Zoologischer Anzeiger, II(43): 632–636.

Ross, H. H. 1929. The life history of the German Cockroach. Trans. Ill. State Acad. Sci., XXI: 84–93.

Shelford, R. 1912. Oothecae of Blattidae. Entomologists Record and Journal of Variation, 24: 283–287.

Westwood, J. O. 1839. An introduction to the modern classification of Insects. Longmans, etc., London. Vol. 1, pp. 419–420.

Wheeler, W. M. 1889. The embryology of *Blatta germanica* and *Doryphora decimlineata*. Jour. of Morph., 3(2): 291–386.

INTROGRESSIVE HYBRIDIZATION, by EDGAR ANDERSON. ix+109 pages, 23 figures. 1949. John Wiley and Sons, New York; Chapman and Hall, London. Price, $3.00.

The author, a geneticist and plant taxonomist, defines "introgressive hybridization" as "the gradual infiltration of the germplasm of one species into that of another." Such infiltration occurs when two related and potentially interbreeding species come together under such circumstances that the hybrids can survive and breed back into the parent stock or stocks. Another pertinent fact is that ecological adaptability and habitat preferences are inherited just as morphological characters are. When, consequently, two interfertile species with different habitat requirements occur together under such circumstances that suitable habitats are provided for their hybrids, these circumstances usually being due to human interference or catastrophic natural changes, introgressive hybridization may occur. The result may, on the one hand, be conspicuous hybrid swarms, or, on the other, more imperceptible but biologically more significant clines extending over a considerable area.

The book includes a consideration of the ecological and genetic bases of introgression and a discussion of the possible role of introgression in evolution. The author believes that introgression is certainly a factor in evolution, but that it can neither be proven nor disproven to be a major factor. His speculations concerning the role of introgression in the development of weeds and crop plants, as a result of human interference with the environment but beginning prior to conscious human selection, are interesting and thought-provocative.

Though written from the botanist's point of view and illustrated with botanical examples, this book opens the way to speculation and possibly experimentation which may greatly influence the concept of the species and of speciation in entomology. Some insect species or species groups are notably unstable in areas like the Rocky Mountains where frequent habitat changes and disturbances occur. If introgression may lead to variability in plants, we should at least consider the possibility of the same happening among insects. Dr. Anderson's little book will warrant careful consideration by the entomologist interested in speciation and species dynamics.—M. T. J.

COLORADO PLEBEIUS SAEPIOLUS

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For some time I have been puzzled for the name to be applied to the Colorado strains of this widespread species. It has generally been called *saepiolus saepiolus* Bdv. At first glance the Colorado material seems to be close enough to the Californian strains to warrant such designations. However, as early as Mead's contribution to the Wheeler Survey (Vol. 5, Zoology, p. 784), it was noted that the Colorado material is darker on the underside than the Californian. With large series of material from California and Colorado before me, another and much more striking difference is at once apparent. The females of the Californian strains are reddish brown, those of the Colorado strains are blue or dull brown broadly marked with blue across the basal halves of the wings. When Mr. dos Passos described *gertschi*, I had hoped that that name could be applied to the Colorado material. It cannot be. *Gertschi* is a diminutive race. It differs in many minor ways from the Colorado strains as will be made evident. The material before me from the Jemez Mountains in New Mexico and all of the ranges in Colorado seems reasonably homogeneous. This is replaced in Wyoming and southern Montana by a strain that is very close to true *saepiolus*. Farther north in the Rockies the strains are close to Edward's *amica*. The Colorado-New Mexico strains I name *whitmeri* in memory of Richard Whitmer of Alberquerque, N.M., an ardent collector of alpine material, who was killed by a fall in the Sandia Mts., N.M. in 1936.

Plebeius saepiolus whitmeri, new race

Males.—Upperside: silvery blue with occasional lilaceous lights and/or greenish yellow irridescences toward the base of the wings. A rather broad dark margin on the forewings and a narrower one on the hindwings. An inconspicuous black spot lies on the discocellular veins of the forewing. Fringe gray-white.

Underside: pale gray with the usual markings of the species well developed and narrowly outlined with whitish scales. Occasionally a little red spot, or several of them in the anal angle of the hindwings, between the two submarginal rows of black marks.

Females.—Upperside: quite variable. The majority (55%) in my Colorado series are dull blue with some silvery and lilaceous lights. (These are easily confused with males of *P. aquila rustica*, differing only in the presence of a little black spot on the hindwing of *rustica*. The undersides, of course, are totally different.) Forewing broadly margined with dark scales. Inner edge of the dark band with barely visible darker interneural spots. Hindwings with distinct marginal and submarginal rows of rounded and triangular dark spots. Occasionally some dull red points in the anal angle between these rows of dark spots.

Almost as frequently the females approach those of ***amica*** and are dull brown broadly shot with silvery blue over the bases of the wings and well across the discal regions. All the intergrades between the two forms are before me from a single locality. Very rarely (3%) the blue scaling is reduced to little more than a basal patch. I have no Colorado material on which the blue is lacking. The brown-and-blue females bear a rather well developed series of reddish or orange spots along the hinder portion of the outer margin of the hindwings.

Underside: ground color dark gray-faun and with the maculation normal for the species.

The above description is a composite based upon about 70 males and 30 females from localities scattered over the state of Colorado. I have selected as types two series from localities that are easily accessable and, being on National Forest land, promise to retain their fauna for some time to come. These types hail from points not more than six miles apart and represent very well the range of variation found in the race.

Holotype.—♂, Rampart Range Road, near Woodland Park, Teller Co., Colorado. 9500 feet, July 2, 1948. Coll. F. M. Brown.

Allotype.—♀, same data (blue form).

Paratypes.—5 ♂, same data as holotype; 3 ♂, 2 ♀, same locality, July 22, 1949; 8 ♂, 6 ♀, Pikes peak Highway above Cascade, El Paso Co. 7400–8500 feet, July 3–9, 1931. (The female paratypes show the entire range of variation). Coll. F. M. Brown.

For a better understanding of the named forms of this species I present the following summary of the studies made to determine the validity of the race I call ***whitmeri***.

DESCRIPTIONS OF SAMPLES

Saepiolus, McCloud, California; the first thirty males in a population series were measured and assumed to be a random sample of the population as of July 15–20, 1932. The statistical parameters indicate that this strain of ***saepiolus*** is a little larger and a little less variable than the average for the species. In an infinite series from this population it is expected that 0.5% would exceed and 4.0% would be smaller than the observed limits.

Saepiolus, Big Meadows, California; the first thirty miles in a series were measured and assumed to be a random sample of the population as of July 2, 1933. The paremeters indicate that although the Big Meadow series is about average in size and a little more variable than average there is no valid difference in size between it and the McCloud series. The larger may have been caused by a greater variety of micro-ecological niches contributing samples to the series. In an infinite series it is expected that 3.0% will be smaller and 0.6% larger than the observed limits of the series measured.

Hilda, San Jacinto Mts., June 10, 1925; Mono Lake July 2, 1932; Pine Knot June 16, 1928; all localities in southern California. There are only seven mounted males of this race in my collection. All were measured. The sample is too small to give more than suggested paremeters for the race. The indications are that ***hilda*** is the largest of the races. It has average variability. It is expected that in an

infinite series about 5.3% would be smaller and 6.1% would be larger than the observed limits.

Insulana, Vancouver, B.C.: My two male specimens of this race do not allow statistical treatment. They measure 13.4 mm. and 14.2 mm. averaging 13.8 mm.

Amica (?), Enfield, Maine June 24–26; Passadumkeag Bog, Maine June 20–27: I have only twelve males of this race from Maine. This is the largest series of the race that I have from localities close enough together to be considered homogeneous. The sample is rather small for firm parameters. Apparently *amica* (?) is about average in size and variability for this species. It is expected that in an infinite series about 0.6% would be smaller and 11.5% would be larger than the observed limits of the sample measured.

Gertschi, Navajo Mt., Utah, July 4–8, 1936: These 29 specimens are believed to be paratypes of *gertschi* although only sixteen are so labeled. The parameters of the sample indicate that the race is definitely smaller and less variable than any other named race of the species. The difference between the mean size of *gertschi* and that of any other of the races is greater than four times the probable error of the difference; thus there is less than one chance in 10,000 that the difference is of no significance. In an infinite series it is expected that 0.2% will be smaller and 1.9% than the observed limits of the series.

Whitmeri, Pikes Peak Region, Colorado: there are twenty-six mounted males in my collection that hail from the Pikes Peak region. They are from various stations between 7400 and 9600 feet elevation, all collected in July. The paramenters of the sample show that this strain is insignificantly smaller than *saepilous* and *amica* (?) and significantly larger than *gertschi*. It is of average variability. In an infinite series about 3.0% will be smaller and 1.6% larger than the observed limits of the measured specimens.

Conclusions: So far as apico-basal length of the forewing is concerned, only *gertschi* is sufficiently different from all other *saepiolus* for this factor to be considered characteristic and valid.

SIZE OF THE MALE

This character was used by Mr. dos Passos as a criterion for *gertschi*. To test the validity of size as a diagnostic character I measured the greatest radius of the left forewing of 134 specimens from several localities. This was done with a Cenco Vernier Caliper (72677). The terminal points used were the tip of the apex inside the fringe and the center of the attachment of the forewing to the thorax. The readings were made to the nearest 0.1 mm. and handled with standard statistical techniques.

The results of these measurements are as follows:

Race	Locality	N	m	σ	V
saepiolus	McCloud, Calif.	30	14.32	0.76	5.32
saepiolus	Big Meadows, Calif.	30	13.90	1.00	7.62
hilda	var. So. Calif.	7	14.66	0.93	6.34
amica (?)	var. Maine	12	13.98	0.92	6.55
insulana	Vancouver Isld.	2	13.8	....	....
gertschi	Navajo Mt., Utah	29	12.37	0.53	4.25
whitmeri	Pikes Peak area, Colo.	26	13.83	0.84	6.06

Sample sizes (N): Four of the samples, both *saepiolus*, *gertschi* and *whitmeri* are small but satisfactory for small sample statistics. The others are too small for satisfactory study with the *amica*(?) sample approaching adequate size.

Mean Size (m): There are no real differences between the average lengths of the forewing of six of the seven samples. *gertschi* is definitely a small race; there being less than one chance in 10,000 that the sample studied could have come from any of the other strains.

Standard Deviation (σ): The standard deviations of the mean length of the forewings of the samples show that in any series the average variation from the mean is about one millimeter except for *gertschi* where it is nearer one-half millimeter.

Coefficient of Variation (V): The degree of variation for all of the races except *gertschi* is relatively uniform. *gertschi* appears to be more consistent in its size than are any of the other races. It may be of interest to note that these coefficients are of the same general order as those that have been determined for the appendages of humans (Pearl, *Medical Biometry and Statistics*, 3rd ed., 1940, p. 358).

RANGE OF LENGTH OF THE FOREWING OF THE MALES

Whenever a series of specimens is measured, it is of interest to determine the theoretic dimension at certain specific points for a series of some standard number of specimens. The following table presents the observed limits of the series measured and the lengths that would encompass 99% of the specimens in a series of infinite number. The measurements quoted are in millimeters.

Race	N	Observed limits	99% limits
saepiolus	60	12.0–16.4	11.3–16.5
hilda	7	13.2–16.1	12.3–17.1
amica (?)	12	11.7–15.1	11.6–16.2
insulana	2	13.4–14.2	.....
gersschi	29	10.9–13.3	11.0–13.8
whitmeri	26	12.2–15.6	11.6–16.0

COLOR OF THE MALES

Upperside: Most of the races have been set apart partially on the basis of the color of the upperside of the males. In all cases it has been indicated that the blue is lighter and brighter than on typical *saepiolus*. My material agrees with this. To me the blue of this surface of the males has these appearances:

saepiolus—silvery violaceous blue.
hilda—silvery lilaceous blue.
insulana—silvery lilaceous blue.
amica (?)—silvery lilaceous blue.
gertschi—silvery gray-blue with occasional lilaceous lights.
whitmeri—silvery gray-blue with occasional lilaceous lights.

Underside: The tone of the ground color and the degree to which the maculation is developed on the underside have been used as criteria for separating the races. My diagnosis of these factors are:

saepiolus—almost white, moderately developed maculae.
hilda—almost white, strongly developed maculae.
insulana—almost white, moderately to weakly developed maculae.
amica (?)—pale gray, weakly developed maculae.
gertschi—pale faun gray, strongly developed maculae.
whitmeri—pale gray, strongly developed maculae.

Conclusions: It will be seen from the above that *whitmeri* approaches most closely the race *gertschi*. This is particularly true of the upperside. On the underside the two are quite distinct. Although both are rather well-marked so far as the black spotting is concerned, the ground color of the males of *gertschi* is much warmer, approaching that of the females of the other races; while of *whitmeri* it is a cool gray and much darker than found on any of the other races.

RED MACULAE ON THE MALES

Between the marginal and submarginal rows of dark markings on the underside of the hindwing there appear on some species red maculae toward the anal angle. Considering only those that are readily seen by the unaided eye, the series studied show the following variation:

Race	N	R obs.	% obs.	99%
saepiolus	60	27	45	28–62
hilda	7	6	86	52–99
insulana	2	0	0	.....
amica (?)	12	5	42	5–78
gertschi	29	18	62	53–71
whitmeri	26	18	69	60–78

In the column headed "99%" are the limits within which the percent of specimens showing red maculae will fall for an infinitely long series. This was computed by means of the Binomial Theorum (Pearl, l.c., p. 336). In none of the cases studied is the series long enough for a reasonably accurate determination. All that can be said is that in any series *hilda*, *gertschi* and *whitmeri* probably will show these spots more frequently than will the other races. The evidence is strong that *saepiolus* and *whitmeri* are truly different in this respect.

COLOR OF THE FEMALES

The coloration of the upperside of the females has been used as a criterion of race in some instances. It appears to me to be more significant than most writers allow and much more so than the color of the upperside of the males.

saepiolus—rusty brown with occasional reddish orange spots at the anal angle of the hindwing, rarely with a reddish orange submarginal band on the hindwing.
hilda—bright rusty brown always with a well developed reddish submarginal band on the hindwings and generally a well developed band a little lighter in color on the forewing.
amica (?)—dull brown, strongly shot with blue in the basal half of the wing; pale orange spot or spots at the anal angle and occasionally well along the outer margin of the hindwing.
insulana—brown with a few blue scales at the base of the wings and occasionally red spots in the anal angle of the hindwing.
gertschi—dull silvery blue with well-developed submarginal dark lunules on the hindwing and a broad dark marginal band on the forewing; rarely yellowish patches of scales at the anal angle of the hindwing.

whitmeri—two forms that completely intergrade, one like the females of *amica* (?) the other like *gertschi*. The *amica*-like females usually have a yellowish orange band along the anal half of the outer margin of the hindwing. The *gertschi*-like females usually have a tiny dark red speck inside the lunule in Cu^2-A.

The frequency of entirely blue females in the various races:

saepiolus—blue females are known but are extremely rare.
hilda—blue females unknown.
insulana—blue females unknown.
amica (?)—no blue females known to me.
gertschi—no brown females known, all are fully blue.
whitmeri—55% of my series are fully blue and no fully brown specimen is known to me.

Underside: The ground color of the underside of the females of this species is consistantly warmer in tone than that of the males. Likewise these surfaces are consistantly more heavily marked than are the males of the same race.

I consider the color of the backgrounds to be,

saepiolus—faun.
hilda—faun.
insulana—gray-faun.
amica (?)—light gray-faun.
gertschi—gray-faun.
whitmeri—dark gray-faun.

Conclusion based on coloration: The race *saepiolus* is characterized by having males with darker blue on the upperside than any other named race. The two California races, *saepiolus* and *hilda* have females that are devoid of blue markings on the uppersides (with rare exceptions among the females of the former race). *Insulana* and *amica* (?) are much alike but the males of the former are lighter on the underside and of the latter less heavily marked on that surface. The females of *amica* (?) are more strongly marked with blue on the upperside than are those of *insulana* and are lighter in background color on the underside. *Gertschi* and *whitmeri* are much alike in color of the males but the former race is significantly smaller. The females of *gertschi* are consistantly blue above while those of *whitmeri* intergrade from *gertschi*-like to *amica*-like in series from the same station. The females of *whitmeri* are totally different from those of *saepiolus*.

GEOGRAPHIC CONSIDERATIONS

On the basis of the above criteria and the limited material spread before me—220 males, 65 females—the following geographic conclusions seem true.

Saepiolus extends from the mountains of central california northward across Oregon and Washington into southern British Columbia (Robson) east of the Fraser River and across Idaho into western Wyoming (Teton and Wind River ranges) and to the forested mountains in eastern Nevada (Wheeler Peak).

Hilda seems to be confined to southern California but may extend up the eastern flanks of the Californian mountains into Idaho (Twin Falls).

Insulana appears to be the race present not only on Vancouver Island, but on the mainland west of the Fraser River in British Columbia (Lillooet).

Amica (?) extends eastward from the mountains in western Alberta through the mountains of Manitoba to eastern Canada and Maine.

Gertschi is restricted to the isolated peaks in southern Utah. (Note: a series of thirty specimens from Wheeler Peak, White Pine Co., Nevada seems to contain typical examples of both *saepiolus* and *gertschi* with 11 ♂♂ and 3 ♀♀ of the former and 15 ♂♂ and 1 ♀ of the latter.)

Whitmeri is known from the Jemez Mts., N.M., the Sangre de Christo Range in New Mexico and Colorado and the following Colorado ranges: La Plata, San Juan, Collegiate, Elk Mosquito, Park, Rampart and Front. It also flies on the isolated Sleeping Ute Mountain in the extreme southwest corner of the state. In Wyoming it may fly in the Big Horn Mountains on the basis of several worn specimens.

There are several mountain areas in the Rockies from which I have not seen specimens and from where it might be of interest to fix the strain that occurs: the San Francisco Mountains in Arizona and the Mogollon Plateau in Arizona and New Mexico (which may harbour the species); the La Sal, Uintah and Wahsatch mountains in Utah; the ranges around Steamboat Springs, Colorado the Snowy and Big Horn mountains in Wyoming.

A DEVELOPMENTAL HYPOTHESIS

On the basis of the above partial information regarding the distribution and appearance of the various races of *saepiolus*, I hazard these suggestions:

1) That in at least the late Pleistocene time the species was divided into three isolated aggregates. One of these gave rise to *saepiolus* on the Pacific Coast and another gave rise to the eastern race *amica* (?) while the third in the mountains of the southern part of the Great Basin produced *gertschi*.

2) That with ameliorating conditions in early recent time, each of these aggregates spread over the land accessable to it until the favorable mountain areas and the spruce-belt across Canada was populated.

3) That as *saepiolus* spread it reacted to the environment and produced *hilda* in response to heat and aridity and *insulana* in response to cold and humidity.

4) That as *amica* (?) spread southward through the Rocky Mountains it produced *whitmeri*, possibly by fusion with some colonies of a *gertschi*-like ancestor.

5) That *gertschi* has been relatively stagnant or even has had its range restricted thus accounting for the low coefficent of variation.

BOOK NOTICES

ON INDIAN INSECT TYPES. II. BIOLOGY, LIFE-HISTORY, AND EXTERNAL AND INTERNAL ANATOMY OF PYRILLA PERPUSILLA WALKER, by M. A. H. QADRI and ABDUL AZIZ. 33 pages, 7 plates. Aligarh Muslim University Publications, Zoological Series, India. 1950. Price, Rs. 4/.

This publication, the second of a proposed series of seven, includes, in addition to the morphological section, considerable information on the biology of the sugar cane leaf hopper, a serious pest of sugar cane throughout India.—M. T. J.

INSECTS OF NORTH CAROLINA, SECOND SUPPLEMENT, by DAVID L. WRAY. 59 pages. 1950. North Carolina Department of Agriculture, Raleigh.

The second supplement of this important list, published in the original form and in the first supplement by the late C. S. Brimley, gives a net increase of 693 species of insects and 126 of "near insects," to make a grand total of 11,910 species recorded for the state.—M. T. J.

THE ASSOCIATION OF ANTS WITH APHIDS AND COCCIDS, by G. E. J. NIXON. 36 pages. 1951. Commonwealth Institute of Entomology, London. Price, 5s. post free.

A SYNOPSIS OF THE WORLD LITERATURE ON THE FRUIT TREE RED SPIDER MITE METATETRANYCHUS ULMI (C. L. KOCH, 1835) AND ITS PREDATORS, by JOAN R. GROVES. With A BRIEF REVIEW OF THE PROBLEM, by A. M. MASSEE. 179 pages. 1951. Price, 20 s. net.

These two titles add to the important review series being published by the Commonwealth Institute of Entomology. The first is primarily a review article, with four pages of references; the second consists largely of an annotated bibliography (that term apparently being used in its true sense) of 1039 titles, prefaced by an introduction and a five-page review.—M. T. J.

ENTOMOLOGY FOR INTRODUCTORY COURSES, by ROBERT MATHESON. Second Edition. xiv+629 pages, 500 figures, frontispiece. Comstock Publishing Company. 1951. Price, $6.00.

The present edition does not show any material departure from the plan of the first and it has the same general purpose, "to interest students and others in the wonderful lives of the insects about us." Except for ten pages devoted to an introduction, sixty-one to the morphology and metamorphosis of insects, and fifty-two to insects in relation to human welfare, the text deals with insects and other arthropods considered according to taxonomic groups. The book is interestingly written; the pages are not crowded with dry taxonomic details, but, rather, contain copious material on the biologies and life histories of insects. The

illustrations are excellent. This should be a very satisfactory text for those who wish to approach the study of entomology from a taxonomic standpoint.

The chief criticism is that a large number of small errors of one type or another but particularly in scientific and technical names have crept into the work—too great a number for a second edition. Another matter of some importance is the choice of material for the keys. It is a very difficult problem to decide whether to mislead the student by over-simplified keys or to confuse him with keys complete enough to work with most material; but in a subject as complicated as insect taxonomy, there seems to be no other choice. Dr. Matheson has chosen, probably wisely, the first horn of the dilemma. In the larger orders his keys are designed to include only the common families. Even so limited, they will not always work. An outstanding instance is to be found in couplet **44**, page **409**, where the Anthomyiidae and Muscidae (Diptera) are separated. Actually, this couplet separates the Anthomyiinae from the Muscidae and the other Anthomyiidae; the genera *Fannia* and *Phaonia*, discussed under the Anthomyiidae, will run in this couplet to the Muscidae. Similarly, couplet **42**, separating the Sarcophagidae and the Calliphoridae, will not always work. Nevertheless, the keys are probably as good as any other set in common usage.—M. T. J.

LONGICORNIA, ÉTUDES ET NOTES SUR LES LONGICORNES, VOLUME I, by P. LEPESME (Editor). 603 pages, 120 figures, 1 color plate, 1 map. Paul Lechevalier, Paris. 1950. Price, 3,500 fr.

Though this volume was issued without an introduction or editorial statement, it is apparently the first of a projected series. It is devoted entirely to the taxonomy of the longicorn beetles, particularly the Lamiinae. Perhaps the most significant contributions are a series of articles by Stephan Breuning (pp. 25–421) consisting of a tribal classification of the Lamiinae and "revisions," including descriptions and keys to the genera and species, of ten of the tribes. Two articles consist of bibliographies of the longicorn writings of Breuning and of J. Linsley Gressitt. Other articles are by Breuning, Lepesme, Pic, A. Reymond, and E. F. Gilmour, the last author writing in English.

The work seems to be well done; the paper is of good quality, the editing apparently satisfactory, and the illustrations well executed and well reproduced. The review copy is paper-bound.—M. T. J.

THE KARANASA BUTTERFLIES, A STUDY IN EVOLUTION, by A. AVINOFF and WALTER R. SWEADNER. Annals of the Carnegie Museum, vol. 32, article 1, iii+250 pages, 17 plates, February 10, 1951.

It is most regrettable that neither of the authors of this monumental publication lived to see it in print. Dr. Sweadner carried on the study after Dr. Avinoff's death, but he too, died early in 1951, before it was published. To lepidopterists who have known the authors their fine personal qualities will remain a happy memory and the study of *Karansas* will stand as a fitting monument to their scientific labors.

Dr. Avinoff's work on the Lepidoptera was interrupted by the loss of his collection to the government of the U.S.S.R. on his departure from Russia, but no government could appropriate his fine and extensive knowledge of the Eurasian fauna. He was able to build up again in this country a superior collection of these butterflies and to carry on extensive studies during the final years of his life. In completing the work, Dr. Sweadner's long association with Dr. Avinoff prepared him admirably to make use of the latter's notes, from which he includes extensive passages, and to formulate conclusions in which both men had shared. The result is a masterly taxonomic study in which the phylogenetic relations of an interesting genus are analyzed to an extent rarely seen.

The revision displays an intelligent comprehension of common problems of classification and phylogeny which all taxonomists might well hope to share. It appears early in a passage from the Avinoff manuscripts on the status of the group

as a subgenus of *Satyrus* or as a valid genus. If only more of us could maintain Dr. Avinoff's "aversion to this—current movement of shifting, changing and restricting generic names!" It seems so important while we are at it and is so trivial in the end!

The same refreshing attitude extends to the interpretation of phylogenetic relationships. It results in a thorough analysis of all points of relationship between the species—genitalia, androconia, color and pattern, and geographic distribution—on a dispassionate basis, and in suggestions of phylogeny correlated with ecological data in a revealing manner.

As a taxonomic study the publication will no doubt long remain authoritative, not only because of the thoroughness and competence of the authors and the extent of the collection on which it is based, but also because existing political conditions are likely to prevent the securing of enough additional material from Central Asia to make revision and expansion necessary. For the latter reason, the work will probably interest few lepidopterists. Even though it may not be widely needed for the arrangement of collections, however, it should be a profitable example to all lepidopterists for its extension of taxonomic procedure beyond mere description and cataloguing.

We salute our departed friends with regret that their work is ended and with unqualified admiration for their final monograph.—A. W. Lindsey.

COMPARATIVE STUDIES ON THE HEAD OF MANDIBULATE ARTHROPODS, by R. E. Snodgrass. viii+118 pages, 37 figures. Comstock Publishing Co., Inc. 1951. Price, $2.50.

To those individuals who were privileged to hear R. E. Snodgrass present a series of selected lectures on Insect Morphology in the Spring of 1946 at the University of Minnesota, this work will serve as an excellent supplement and review on those lectures relating to the anthropod head structure. This monograph is the first in a series of new "Cornell Studies in Entomology" and is the result of a similar series of lectures on this subject presented by the author in May 1950 at Cornell University. In this brief book, the author presents, in concise, but in his usually clear and interesting fashion, a graphic picture of relationship of head structures of the Crustacea, Chilopoda, Diplopoda, Pauropoda, Symphyla and Hexapoda. It is well-illustrated in Mr. Snodgrass's usually fine technique with 37 plates, each consisting of 5 to 10 figures, each clear to the smallest details. The final chapter presents a logical and utilitarian summary of the fundamental anthropod head structures, together with a comparison of the head structure of the several groups of arthropods discussed by the author. To the beginning graduate student, this work should serve to supplement a general text in courses in General Entomology or Insect Morphology, especially as regards the varied features of the mandibulate arthropod head, to the seasoned morphologist it should prove a useful review of the widely diverse and fundamentally difficult material on the subject. It is noteworthy that, while no attempt is made to interrelate arthropods phylogenetically from the evidence presented, the author has presented, stepwise, a convincing set of data which must lead inevitably to some positive, logical conclusions concerning such interrelationships among the arthropods.
—M. Rockstein.

DESTRUCTIVE AND USEFUL INSECTS, THEIR HABITS AND CONTROL, by C. L. Metcalf and W. P. Flint, revised by R. L. Metcalf. xiv+1071 pages. Third Edition. 584 Figures. McGraw-Hill. Price, $10.00.

Probably no reference has been of more value to students, teachers, fieldmen and others engaged in insect control than the 1928 and 1939 editions of Metcalf and Flint. This book is a classic. The third edition, revised by the son of the late C. L. Metcalf, will unquestionably receive the acclaim accorded the earlier works. Little has been taken away and much new knowledge has been written. The arrangement and sequence are unchanged. Several sections have been drastically revised. This is particularly true with the chapter on insect control

and to a lesser degree, the discussions on physiology and allied fields, an area where Dr. Metcalf has become an authority in his own right.

The second half of the book which embodies the field keys, discussions on importance and type of injury, hosts, distribution, bionomics, appearance and control have been brought up to date as much as possible. The newer important references are included. Most of the excellent illustrations in the earlier editions were preserved and new ones added.

It is highly appropriate that Dr. Metcalf undertook to write the Third Edition. He had opportunity to assist in the preparation of the second edition. Probably no one was more familiar with the book or with the authors and with their intent. Never in the history of applied entomology has there been such a need for such a book. This need has been amply met.—H. S. Telford.

THE DEUTSCHES ENTOMOLOGISCHES INSTITUT

The following communication has been received from Dr. Hans Sachtleben concerning the article by John Wendell Bailey, 1947, "Reports on the status of the entomological collections in certain European museums," Ann. Ent. Soc. Amer. 40: 203–212.

"It is right that the collections of the Deusches Entomologisches Institut were evacuated on account of the air-attacks in 1943 to Blücherhof, Post Vollrathsruhe, Mecklenburg. But it is *wrong* that 'The library was not moved until July, 1945:' The library was moved together with the collections in August, 1943, to Blücherhof.

"In the former building of the Entomologisches Institut at Berlin-Dahlem, Gosslerstr. 20 remained only duplicates of insects and books of little value. These duplicates were destroyed partly by American soldiers after the American troops requisitioned the building; the remainder of the duplicates were saved by Prof. Dr. E. M. Hering, who is, however, not 'First Trustee of the Deutsches Entomologisches Institut' but curator of the Diptera and Lepidoptera of the Zoologisches Museum of the University of Berlin.

"Except for these duplicates of little value all the insect collections, the whole library and all other things of value, e.g., the large card index of entomological literature came undamaged through the wartime at Blücherhof.

"In the first months of 1950 the whole Institute was moved back from Blücherhof to Berlin and is now located in a new building at Berlin-Friedrichshagen, Waldostr. 1.

"The Scientific staff of the Institute is now: Prof. Dr. Hans Sachtleben, Director; Dr. Willi Hennig and Dr. Siegfried Wolf, Division of systematic entomology; and Prof. Dr. Walter Tomaszewski and Dr. Wolfgang Schwenke, Division of applied entomology.

"Dr. Walther Horn, the former Director of the Deutsches Entomologisches Institut, died in 1939 (not as indicated by Mr. Bailey, 1944)."

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Papers should ordinarily be submitted directly to the Editor. However, they may be submitted to any member of the Editorial Board, especially where such member is particularly qualified in the subject matter of the paper.

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